ENGINEERING AND MINING JOURNAL

A McGRAW-HILL PUBLICATION

MAY 1961

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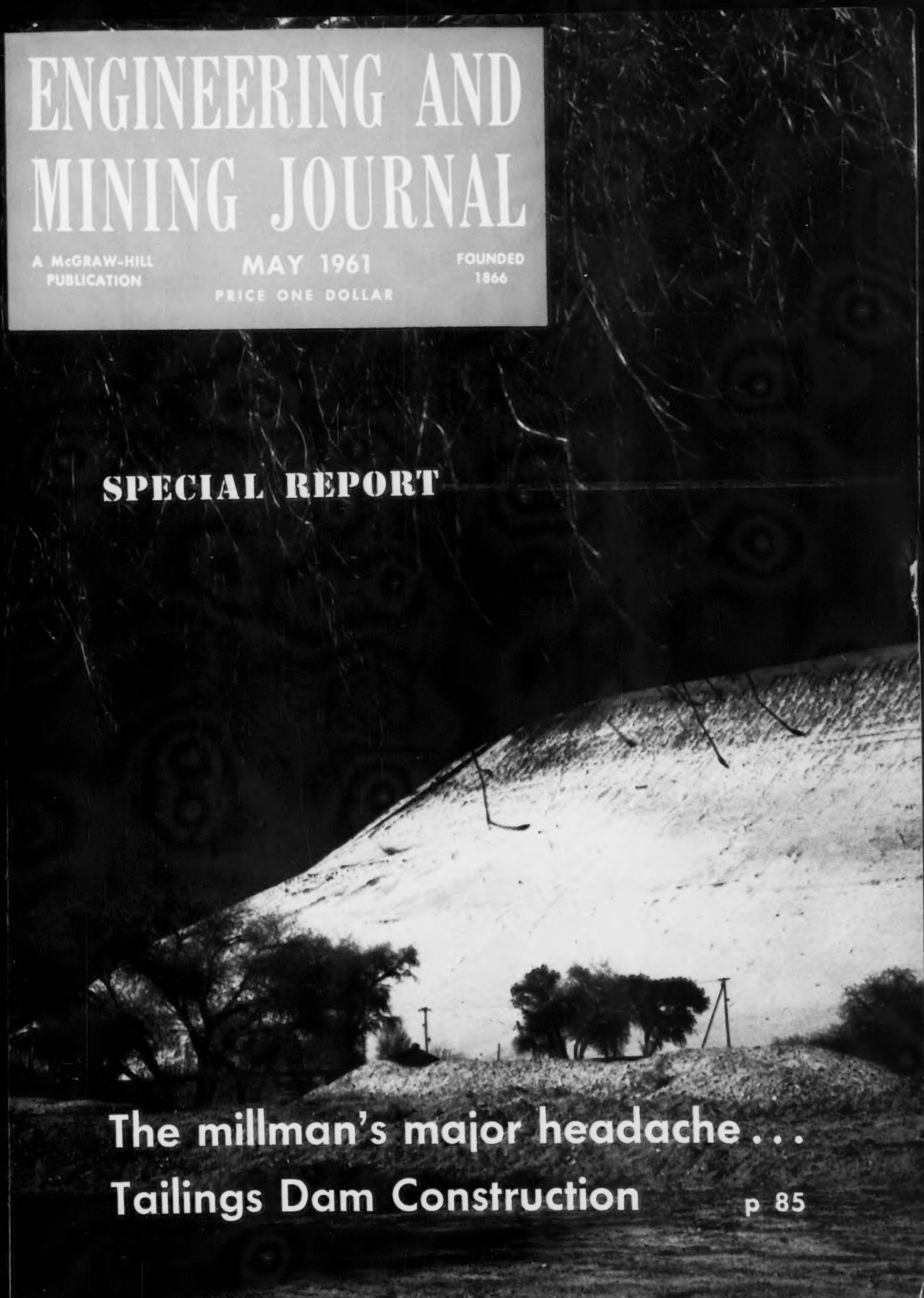

SPECIAL REPORT

The millman's major headache . . .

Tailings Dam Construction

p 85

Mining Calendar

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A report of E&MJ's education survey of the mining industry;

A three-page article on the life of drill steel; and

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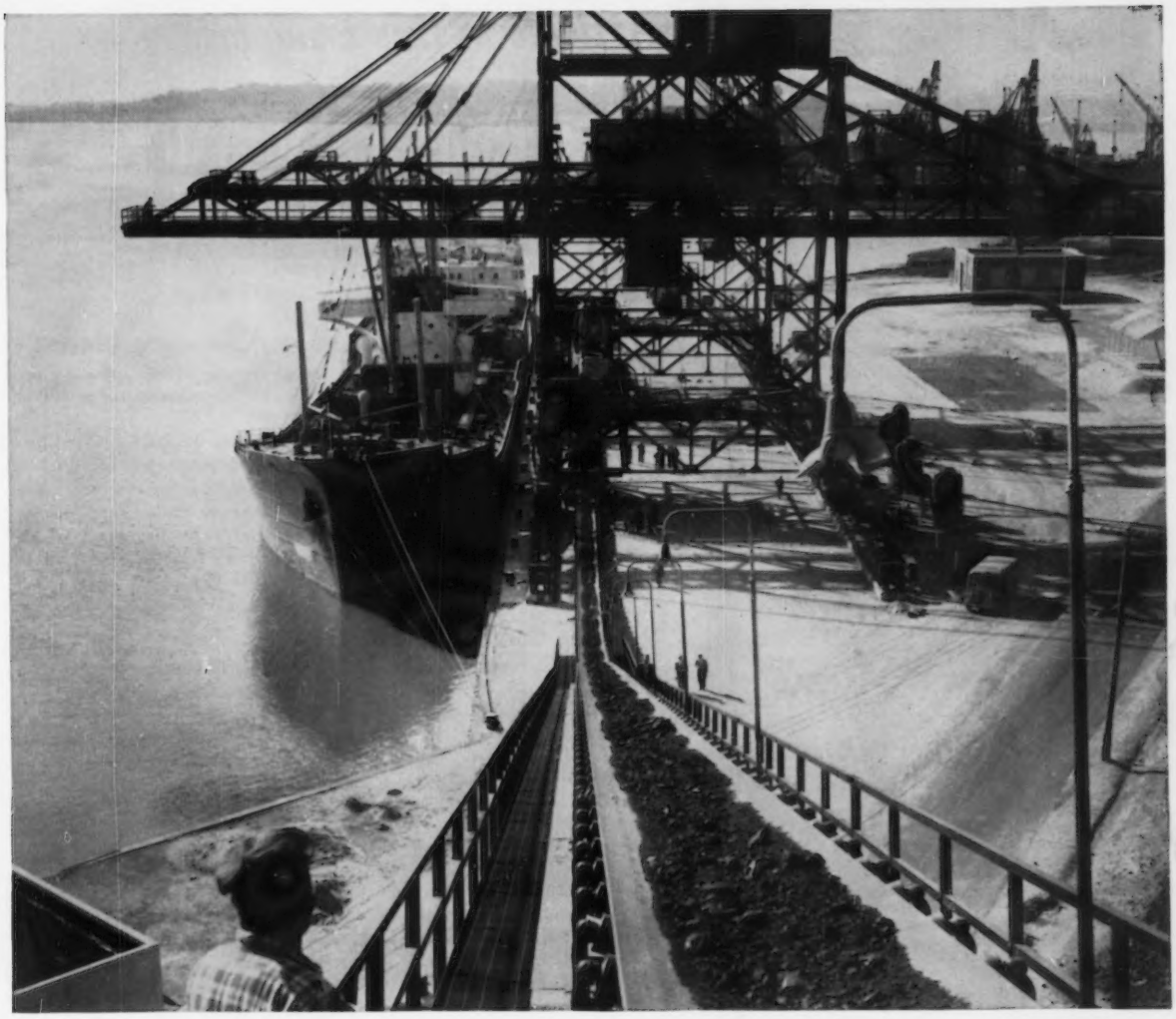

Belt gets up and goes— unloads ore ships in a hurry

After 9 million tons, B.F.Goodrich belt still going strong

At this pier, iron ore is unloaded from ocean-going freighters at a 2000-ton-an-hour clip. The conveyor belt rushes it up to waiting railroad cars. The whole system works so well that even the largest ore-carrying vessels can be emptied in less than 24 hours.

To stand the heavy loads, the speed, and to insure continuous operations, the engineers in charge selected a B.F.Goodrich conveyor belt. Special chemicals, developed by BFG, were added to the rubber to keep the belt "live" and elastic, help it resist the effects of air, sun, weather. Patented layers called "breakers" were built into the belt to increase impact resistance.

The trouble-free performance of the B.F.Goodrich belt has helped make this B & O Pier, Curtis Bay, Maryland, one of the biggest, fastest and most efficient ore-handling facilities on the East Coast. And after carrying nine million tons, the BFG belt is still in good condition.

But good as this record is, chances are that it will soon be bettered because of the improvements that are constantly being made in B.F.Goodrich belts. In recent years, for example, the use of improved rubber compounds and stronger fabrics has resulted in belts that can carry heavier loads farther and faster than ever before, and last longer doing it.

B.F.Goodrich distributors have full information on the belt described here. And, as factory-trained specialists in rubber products, they can answer your questions about the many rubber products BFG makes for industry. *B.F.Goodrich Industrial Products Co., Dept. M-996, Akron 18, Ohio.*

B.F.Goodrich

CONVEYOR BELTS

It has been done

One D-6-5 HYDROSEAL

instead of as many as four smaller pumps.

One installation for the job to be done!

In applying this economy to pumping abrasives-corrosives, it is important to select the elastomer and metal parts according to the conditions. The experience of A-S-H engineers will be of help.

THE ALLEN-SHERMAN-HOFF PUMP CO.
Dept. B—P.O. Box 635, Paoli, Pa.
Representatives throughout the World

HYDROSEAL *and* CENTRISEAL

SAND, SLURRY & DREDGE PUMPS

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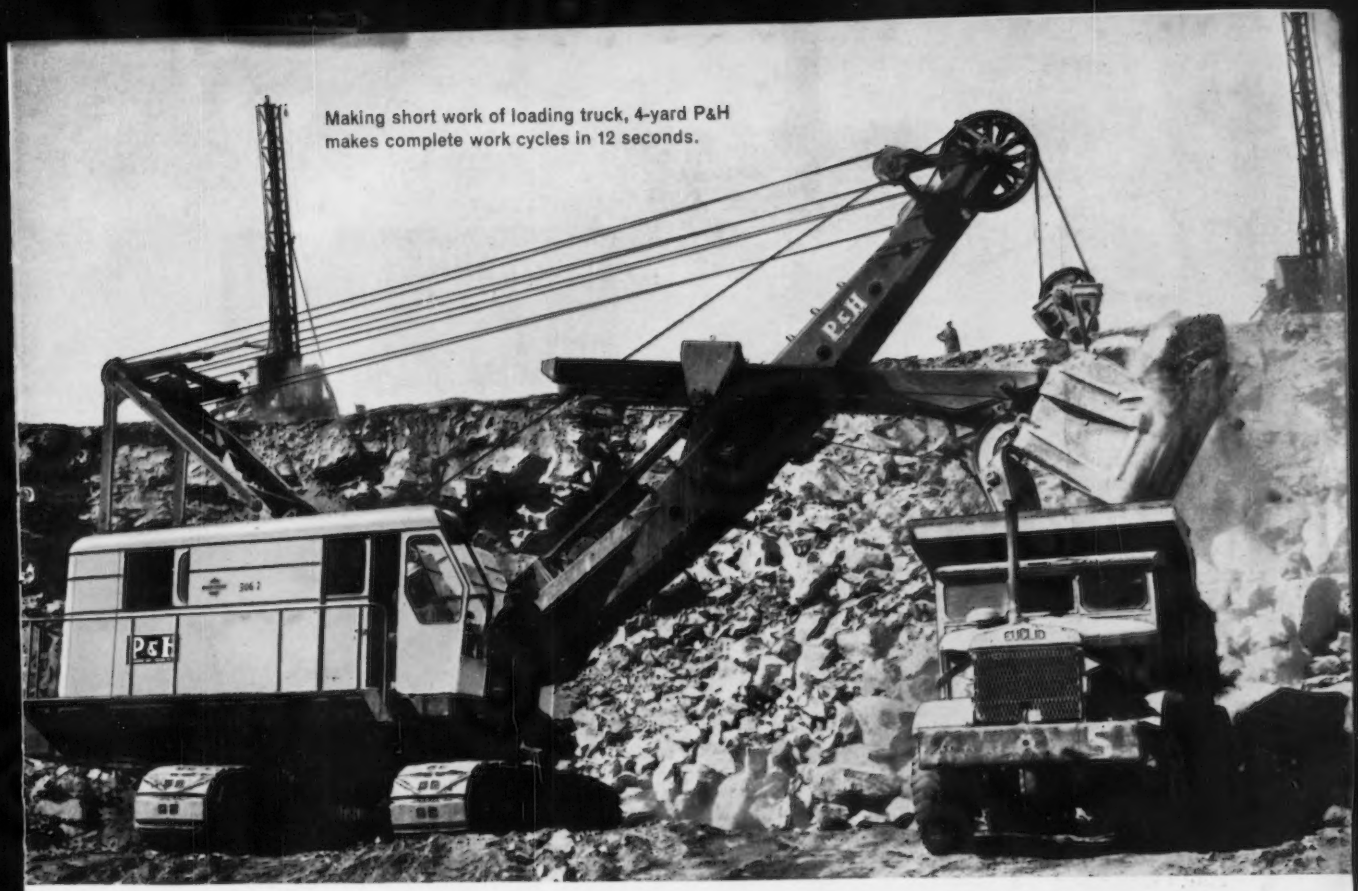

Making short work of loading truck, 4-yard P&H makes complete work cycles in 12 seconds.

Magnetorque swingers are the reason . . .

"4 yard P&H out-produces two 2½ yard shovels"

. . . STOCKBRIDGE STONE COMPANY, Atlanta, Georgia
Division of VULCAN MATERIALS COMPANY

Powerful P&H handles heavy rock with tireless ease as it works 16 hours a day digging and loading shot rock.

J. G. Lambert, Superintendent, has this to say about his operation— *"Our 4 yard P&H shovel, with Magnetorque swingers, accounts for more than half of the yardage produced at our Fortson quarry. It actually produces more than both of our other 2½ yard shovels combined."*

12 to 15 seconds work cycles. Stockbridge Stone supplies aggregate throughout Georgia, Alabama, and to four company-owned plants that manufacture concrete blocks and ready-mix. Of prime importance to them is the speed and dependability with which their shovels can excavate rock and load trucks to keep their processing plants in production. This company reports that their P&H shovel loads 18-ton trucks in 5 or 6 passes with work cycles averaging 12 to 15 seconds.

Edward Pitts, operator of the P&H says that Magnetorque swingers are the reason he gets better than 25% faster work cycles. He points out that Magnetorque swingers, unlike friction-type clutches, never over heat, and are not affected by temperature changes or load size.

P&H works two 8 hour shifts per day. To meet the heavy demand for aggregate, Stockbridge operates their 4-yard P&H shovel on a 16-hour day . . . and they operate in all types of weather, even the heaviest rains. This company has proven to itself that P&H delivers exceptional performance under the most rigorous conditions—steady, fast cycles with no downtime other than normal preventive maintenance.

Another feature, "Bud" Lambert stresses, is the propel brake on the P&H—this brake control gives more productive working time because it eliminates the constant need to "dog" or "undog" the machine with clumsy jaw clutches for every move.

For more information on this job, write for Case History 136.

HARNISCHFEGER P&H
Milwaukee 46, Wisconsin

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B.F.Goodrich

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ENGINEERING AND MINING JOURNAL

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82 Dateline Philadelphia—The Symposium on Agglomeration

Specialists in the fields of sintering and pelletizing: design, operation, performance and research, gathered for the first international symposium on agglomeration last month in Philadelphia.

The wealth of information they offered represents the present-day position of one of our fastest-improving technologies. The papers ranged from iron ore through the base metals and into nonmetallics, with performance data, temperatures and equipment cited and criticized by leaders from all over the world. Some of the highlights of the papers, with brief reports of the questions which came up in discussion, are covered in the article's three pages in the feature section and continued in the back of this issue.

92 Cutting Costs at Kennecott's Mines

Kennecott Copper installed an Industrial Engineering Department at its Utah Division in 1954. By the end of the first year, 45 I.E. projects had shaved $140,000 per year from the estimated costs. And since then, savings through industrial engineering have never gone under $500,000 a year, and, in 1957, exceeded $1.5-million. Among the innovations: a methods improvement program; adding the "work center" concept to the line organization; and improving cost control.

100 Jet Piercing Progress—The Follow-Up

Jet piercing was introduced for hard rock primary blast hole production in 1947. Since then, the Linde Co. has been continually redesigning and improving the blow-pipe and auxiliary equipment, and modifying piercing procedures to meet the specific field problems. In this report, J. J. Calaman and H. C. Rolseth, both from Linde, review the blowpipe's basic parts, and then, with a number of graphs and tables, show how production, hole shape, and operating times have become more and more efficient during the past 13 years.

85 Building Tailings Dams: Where the Soils Engineer Can Help

Modern mining techniques are leading to an increase in the problems of tailings disposals and dam maintenance, but tailings dam construction has never really received adequate discussion in mineral dressing literature. Thus many mill operators have continued using improper and outdated methods on a problem that can be solved by correct application of the principles of soil mechanics and earthwork engineering.

The soils engineer can combine theoretical soil mechanics—with emphasis on the concept of effective stress—and practical earthwork engineering to obtain this crucial result: safety factors for embankment stability. With the right data from the mine operator, the soils engineer can analyze existing embankments and examine prospective disposal areas.

91 Air-Decked Charge Improves Blasting

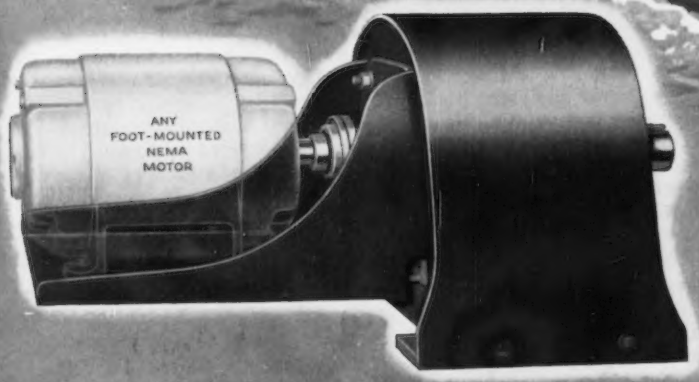
By redesigning AN/FO charge distribution to include air spaces, Prof. N. V. Mel'nikov of the USSR Academy of Sciences was able to get better fragmentation and increased yield from 8-in. drill holes. Apparently much of the energy that formerly caused a pulverized zone around the drill hole now is transferred away from this zone to areas where it can do more useful work.

98 How an Automatic Underground Loading System Cut Costs

"Sachtleben" AG, the leading West German pyrite producer, is saving about 9¢ per ton by automating its underground loading system. The completely automatic operation is controlled by electric eyes and horn signals.

FALK

A GOOD NAME IN INDUSTRY



20,000 hp at 100 rpm

...or 75 hp at 100 rpm

THE FALK *ALL-STEEL*, ALL-MOTOR MOTOREDUCER
(also available in integral models)
...one of America's First Family of Power Transmission Products

RING GEARS ▶
Single helical or herringbone, solid or split designs. For mill and kiln applications.

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DIAMETERS:
up to 23 ft. 9 in.

FACE WIDTHS:
up to 6 ft.

DIAMETRAL PITCH:
¾ to 6 dp.

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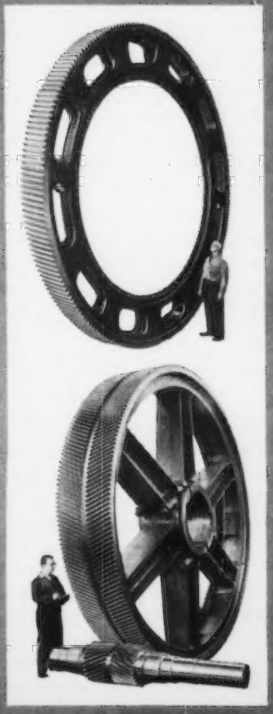
HUB GEARS ▶
Single helical or herringbone, solid or split designs. For mine hoists, special drives.



FALK, ALL-MOTOR and STEELFLEX are registered trademarks.

If you were in the market for a 20,000 hp propulsion drive for a blue-ribbon super-tanker, you would expect and demand the ultimate in gear accuracy. On turbine-driven gears as large as 15 feet in diameter and four foot face width, any deviation in tooth-spacing tolerances of .0001" to .0002" would spell poor performance or disastrous failure...the latter entailing loss of service of the ship and ruinously expensive repairs or replacements.

Falk, producer of millions of horsepower of marine propulsion drives for nearly fifty years, has been continuously adding to its gear making experience and techniques—and applying the results to all products, standard drives as well as large special units, with the same full respect for the importance of accuracy. Today's versatile All-Steel Motoreducer is a striking example of the application of these attitudes and skills in producing the many standard gear units used throughout your own industry.

Falk gears have the highest known efficiency...98½% per mesh under full load...plus the famous Falk extra-depth, high-pressure-angle teeth. Benefits to you: better service, less maintenance, extra durability, true economy. Available in horizontal, vertical and right-angle models; sizes up to 75 hp. See your Falk Representative or Authorized Distributor—or write for Bulletin 3100.

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN
MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS
Representatives and Distributors in most principal cities

• • •

A POINT TO PONDER...*when you need gear drives or shaft couplings of "FALK OR EQUAL" quality, where but from Falk can you get the "OR EQUAL"?*

95 YEARS OF MINING

The following news items are reprinted substantially as they first appeared in the AMERICAN JOURNAL OF MINING, the publication which became *E&MJ*.

MICHIGAN, MAY 1866—From the Houghton GAZETTE: The entire mining force at the Calumet was discharged last week; we suppose that the breaking up of the winter roads compelled this movement. The lode is reported as "looking keenly," and that there was a good show of "stamp copper" in the bottom of the pit.

NEVADA, MAY 1866—From the Humboldt District: The Chloride is a ledge located in Arabia last season, and of which but little was thought. It was sold for $150. Recently, the parties making the purchase made an examination. The ore is found to be of good width, well cased, and an average sample of the ore assays $400 to the ton.

COMSTOCK, MAY 1866—From the San Francisco NEWS LETTER: The market for Imperial has been firm; the demand for the stock has been to fill shorts. Large sales were made at $148. There is nothing in the mine to warrant the price . . . The Confidence is taking out ore from their upper works, the lower levels showing nothing of value.

COLORADO, MAY 1866—From the Black Hawk JOURNAL: Mr. Fitzpatrick reported another gold egg yesterday, weight one hundred and seventy-one ounces, value $2,736. Last week it was ten ounces, or $160 less. Mr. Perrine believes he has at last struck the Washcash lode, for which he has been looking since Colfax was here last summer.

MONTANA, MAY 1866—The Vigilance Committee takes care of the immoral in Helena, and every few days, in a dry gulch half a mile from town, a man can be seen "looking up a tree." The Committee do not try a man openly here, but in secret—and the first a fellow knows he is tapped on the shoulder and told his uncle has arrived and wishes to see him; the next, he is quietly walked up Dry Gulch, and in the morning is found on Hangman's Tree.

This month in

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Continued from p4

Behind the By-Lines

They had a real nice clambake in Philly last month. Its formal name was "The First International Symposium on Agglomeration," and we hope it will serve as a prototype for any and all mining industry gatherings in the future.

The speakers, half of them from abroad, had supplied copies of their papers in advance and preprints were mailed to pre-registrants; the talks were held to a time limit, as were the questions and answers; there was only one evening affair (Philadelphia has some fine restaurants); authors were available for more questions at the daily informal luncheons (see p 82). True, one half-day was devoted to concurrent sessions, but we suppose there'll never be an answer to that problem.

We'd guess that the Philadelphia group, and Bill Stephenson, the general chairman, came as close to a perfect meeting as we're likely to see.

Perhaps it was that proximity to perfection that reminded us of a phantasmagoria which came to us, as in a dream, after a particularly hot, humid, foot-weary five-day endurance contest in Los Angeles several years ago.

In our apparition (obviously brought on by an air inversion occurring while Venus was in the descendant) we were attending a convention in a strangely roomy, airy city in which everything was within walking distance. It rained occasionally, but only between the hours of 1 am and 6:15 am.

And the hotel! Ah, there was a hotel. Room service was prompt and reasonable. The one-day laundry service got the laundry back within 24 hours. The food was good, the beds were soft, the water was hot, the beer was not.

The room was equipped with a closed circuit television which could be tuned in to the convention floor. Speakers' talks were illustrated and brief; and available before the meeting for study.

No, don't send for the wagon; we're all right now. It was just an idea . . .

Speaking of the hazards of conventions, we are happy to pass along the following definition. It appeared in an excellent Arizona small mine operators' paper, PAY DIRT, published by Charles Willis and edited by the very capable "R.G." Moore.

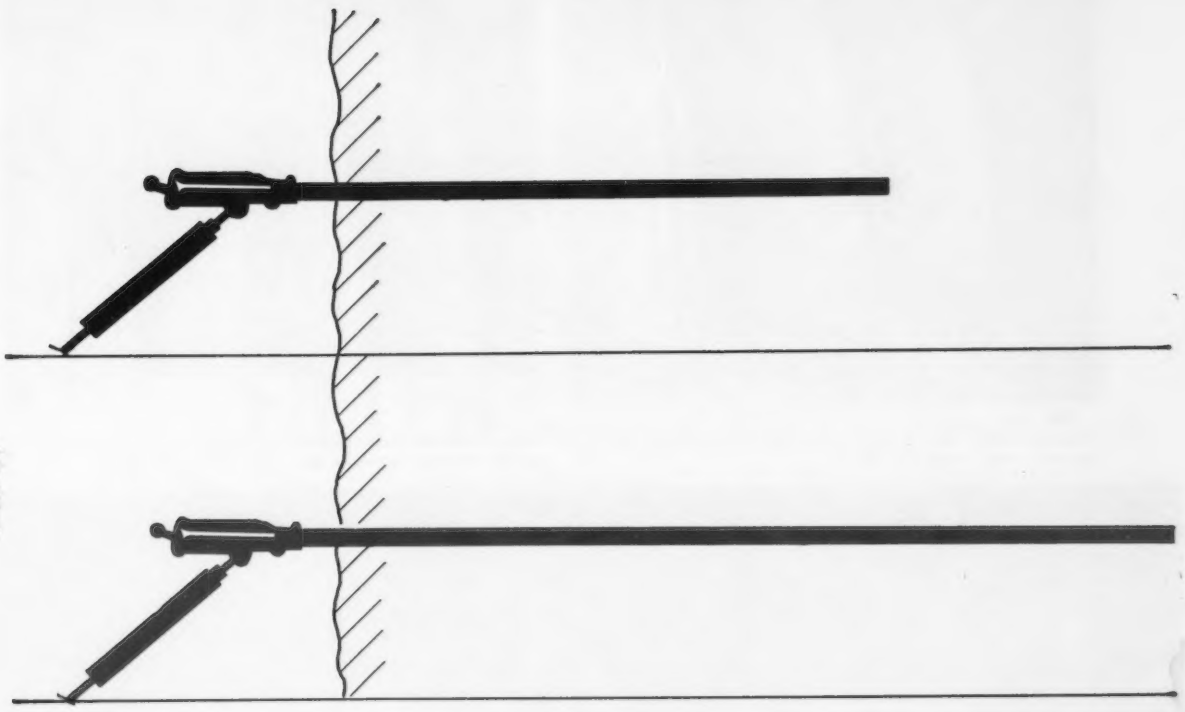
The two-liner describes the new jet age as: "Breakfast in London, lunch in New York, dinner in San Francisco and baggage in Buenos Aires."

Number Two in a series of special reports on trends and problems in the mining and mineral processing industry appears on p 85.

Like its predecessor, on the direct reduction process in iron ore (December 1960), it is an attempt to examine some aspects of mining that have either grown rapidly in recent months or are in need of textbook treatment to give you a background for current and future decisions.

This month's effort, in the field of tailings, dam stability and dependability, suggests the techniques of soil mechanics as a tool in the building and maintenance of dams.

Subsequent special reports will treat other areas and problems. In July: What the mining man should know about power conversion.



It's the hole truth... 50% FASTER

NEW JR-300 JACKDRILL.

Never before in the history of rock drilling has there been a feed-leg drill that could do so much, so easily, as Ingersoll-Rand's new JR-300 Universal Jackdrill. On performance alone, it is 40 to 60% faster than preceding models.

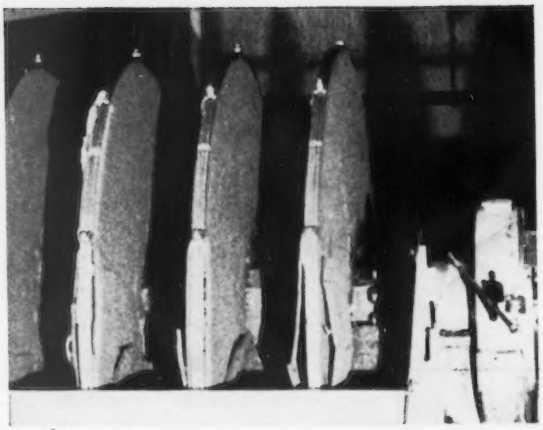
The JR-300 is a lightweight, completely integrated rock drill and flexible air-feed leg unit designed for faster, easier drilling in any position. Three feed legs are available with this new machine: conventional single-acting, telescopic and a new double-acting automatically retractable feed leg. All controls are conveniently grouped on the backhead and the feed handle has a two-position button for feed release or leg retraction which reduces steel changing time and speeds setups.

The same fine performance and design features are available in the new R-300 Stoper and J-300 Jackhamer, simplifying parts inventory where all three types of machines are used.

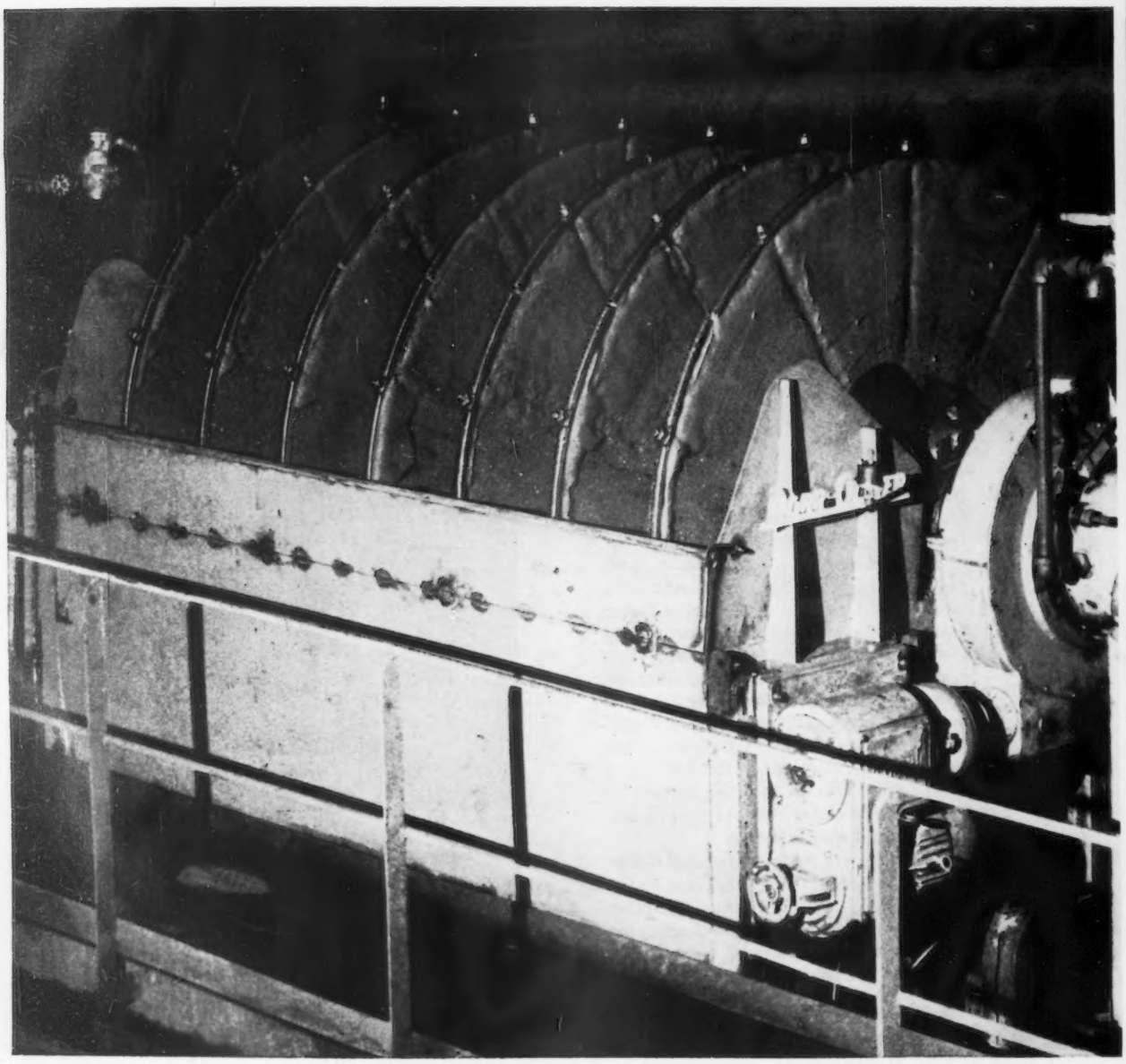
Ingersoll-Rand®
229A5 ♥ 11 Broadway, New York 4, N. Y.

A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR DRILLING ROCK

Close-up of filter discs illustrates high degree of water removal. Bags are almost completely dry.



Clean discharge of filter cake, after the snap blow, is shown in this photo. Blow-back problems have been largely eliminated.



How they licked a tough filtration job at The Cleveland-Cliffs Iron Company ...with **AMERICAN Disc-Type FILTER** *for Iron Ore Concentration*

De-watering re-ground specular hematite, prior to the pelletizing operation, has presented a difficult job at The Cleveland-Cliffs Iron Company's Eagle Mills Pellet Plant, Eagle Mills, Michigan. Feed to the filter contains about 72% solids. The material is heavy and hard to keep in suspension. A high degree of moisture removal and continuous, high tonnage operation is necessary for economical processing.

Close cooperation between Dorr-Oliver engineers and the mill operators has resulted in a successful solution. A 6'9" x 7-disc American Vacuum Filter, designed specially for this operation, is used. The photographs demonstrate the excellent results being achieved. Cake is discharged with an average moisture content of 7.5% to 9.0%. Output runs as high as 118 long tons per hour. Maintenance requirements have been kept to satisfactorily low levels.

The know-how of Dorr-Oliver engineers is based on over 50 years of handling every type of filtration problem, using every type of filter. For information on the wide range of Dorr-Oliver equipment or for assistance on your particular operation, write to Dorr-Oliver Incorporated, Stamford, Connecticut.

DORR-OLIVER

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Pre-Engineering by **KAISER ENGINEERS** answers basic plant expansion questions...

Raw Materials?

Your final decision to expand or build results from a series of important individual decisions. Raw material availability is one of them. Independent analysis of all aspects of your proposed program is the *Pre-Engineering* service offered by Kaiser Engineers. In addition, KE is an experienced designer and builder of all types of facilities for the Minerals industry. From Pre-Engineering through design and construction Kaiser Engineers provides complete one-company service and ingenuity based on years of experience.

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6231-M

You never had 'em so tough!

HARD ROCK LUG XTRA TRED

Here it is! From Goodyear's advanced technology and processes—

HARD ROCK LUG XTRA TRED—the mine and quarry tire that's built with extra tread to take it where the going's tough!

It's made with 3-T Nylon Cord—triple-tempered by Tension, Temperature and Time—that makes *the world's toughest tire bodies.*

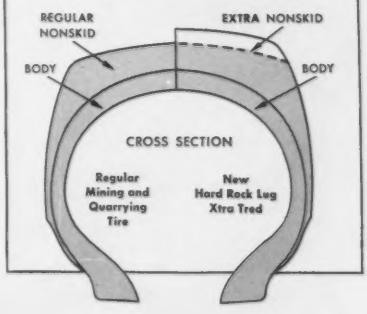
It has specially compounded rubber that embodies remarkable super-toughening agents for far greater chip-, wear- and penetration-resistance—that produces *the world's toughest treads.*

And, with its thicker nonskid tread depth (as much as 71% thicker) for harder-biting, longer-wearing lugs, you take out *more pay loads in less time and at lower cost*—with fewer maintenance headaches, too!

Ask your Goodyear dealer about Hard Rock Lug Xtra Treds, *now.*

Goodyear, Truck Tire Department, Akron 16, Ohio.

MORE AND TOUGHER RUBBER IN THE RIGHT PLACES!

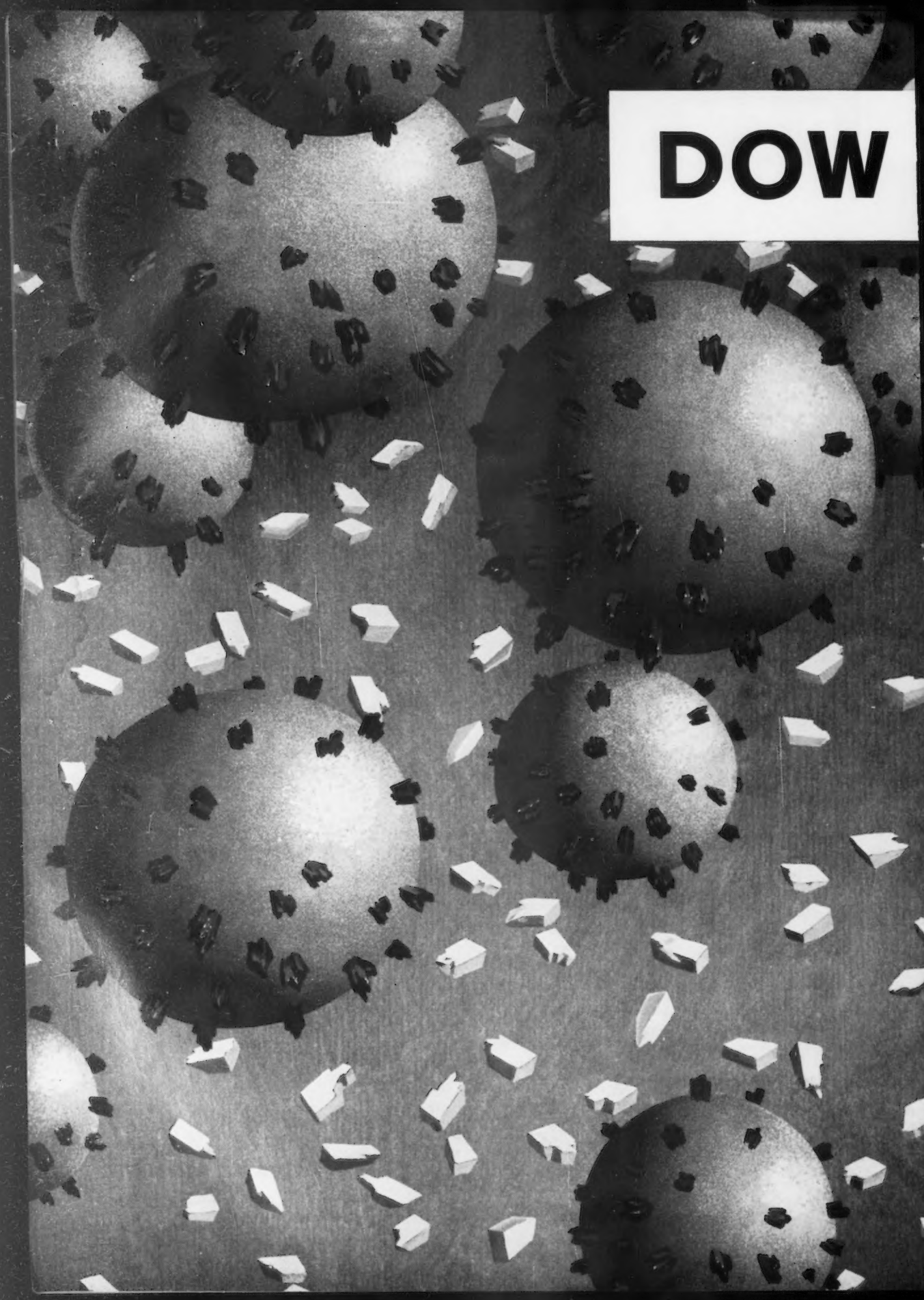


THE WORLD'S TOUGHEST TRUCK TIRES BY

GOODYEAR

Xtra Tred—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

MORE TONS ARE HAULED ON GOODYEAR TRUCK TIRES THAN ON ANY OTHER KIND


DOW

mining chemicals

Z-200

BETTER COPPER-PYRITE SELECTIVITY, LOWER LIME COSTS WITH Z-200

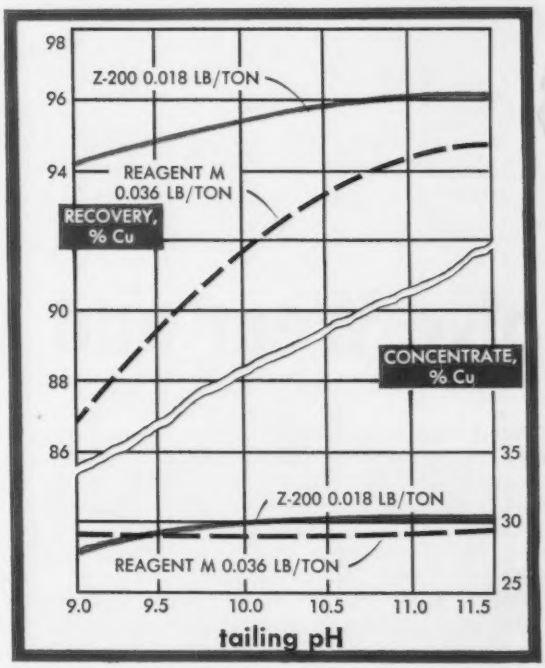
Mill-scale separations of copper from copper-pyrite ores show that Z®-200 flotation agent is without doubt the most selective copper or copper-activated zinc mineral collector available to flotation metallurgists today.

Z-200 flotation agent is a *water-insoluble liquid* stable in both acid and alkaline pulps. Chemically, it is a dialkylthionocarbamate and offers metallurgists an entirely new structure to work with.

Since Z-200 is more selective against pyrite than any other collector, it requires only a minimum amount of control to smooth out operational fluctuations and ore changes. Also an advantage is the fact that an excess of Z-200 floats substantially *no* free pyrite, especially in lime alkaline pulps above pH 9.

On many ores, the use of high lime alkalinity in zinc flotation results in excessive gangue carry-over into the concentrate. Z-200 provides an excellent answer by lowering lime requirements. In addition, tests with Z-200 in zinc flotation at a pH of 9.5 produced a 50% zinc rougher concentrate—a big jump over the usual 29% produced at the same pH with the standard xanthate. So where lime costs at a particular location are a factor, or where multiple cleaning of the concentrate at the mill is prohibitive, Z-200 should be evaluated.

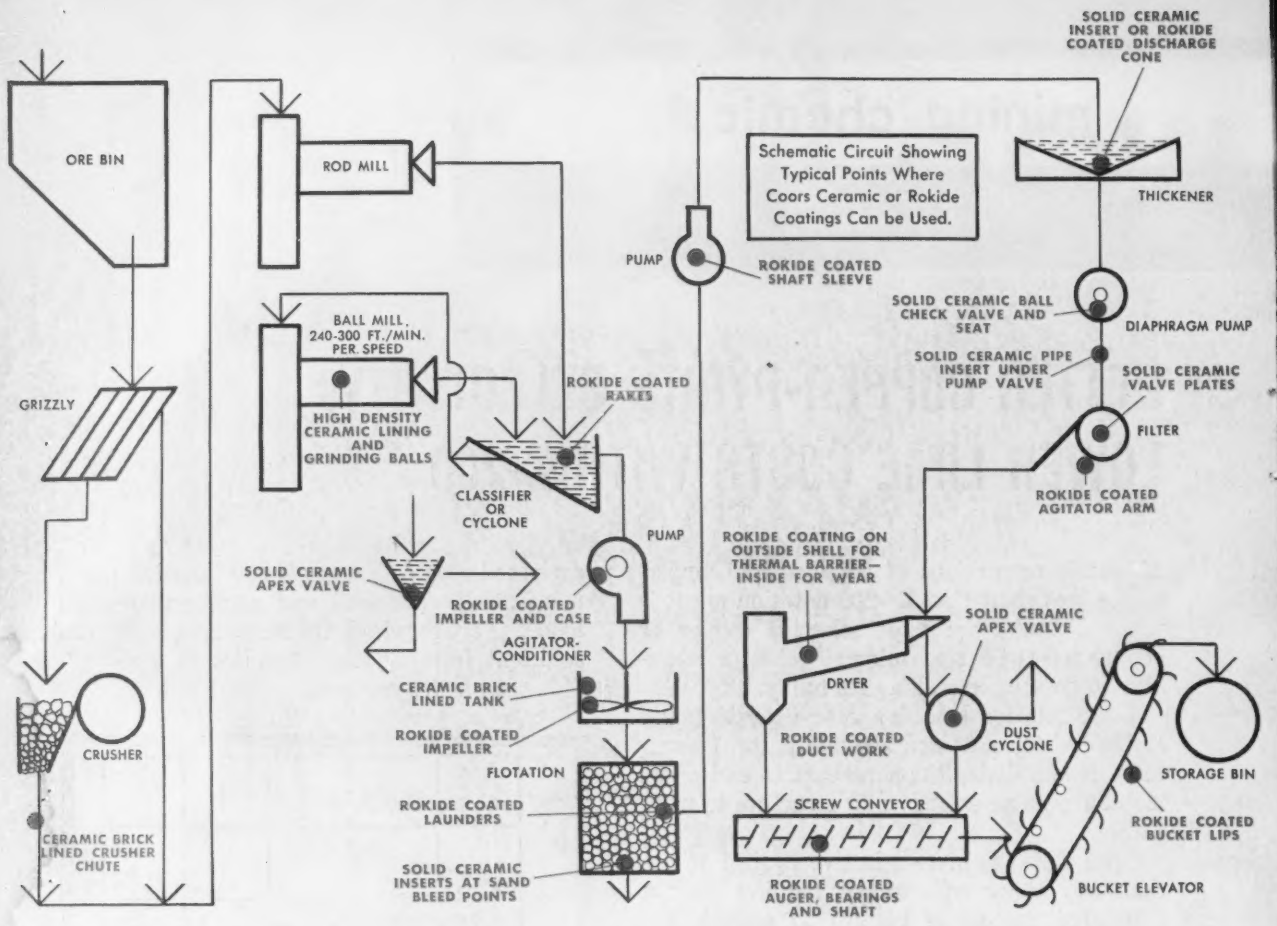
Compared to other copper and copper-activated zinc collectors, Z-200 flotation agent is unusually powerful and smaller-than-usual amounts are required. On many ores, Z-200 has sufficient frothing characteristics to provide a reduction in frother costs.



Comparison of Z-200 with standard collector on high-pyrite copper ore

Since ores have a way of changing just when you have everything going nicely, Dow maintains a special group of mining and milling experts who can be extremely helpful if problems arise. Their services are available either in writing or in person. They will be happy to assist you in any problem having to do with mining chemicals. For a copy of our new digest *Chemicals for the Mining Industry* write to THE DOW CHEMICAL COMPANY, Abbott Road Buildings, Midland, Michigan, Attn: Chemicals Merchandising Dept. 752BD5.

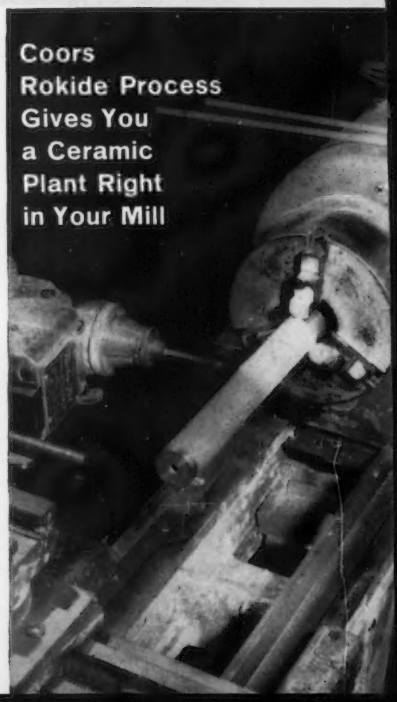
THE DOW CHEMICAL COMPANY DOW Midland, Michigan



ALSO: MECHANICAL PUMP SEALS; MULLER WHEELS AND PLATE; METERING ORIFICES

Solve Wear and Corrosion Problems

Critical wear and corrosion points in your circuit can be protected with Coors high strength ceramic parts or coatings. Solid ceramic parts are sapphire hard (Rockwell 45N 75-81), and strong (over 30,000 psi Tensile Strength, over 350,000 psi Compressive Strength)—providing high resistance to wear and abrasion. The ceramic is virtually inert to chemical attack. Rokide ceramic spray coatings have many of the advantages of the solid ceramic parts. Take a look around your mill and see if Coors Ceramics can help you solve critical wear and corrosion problems. Write for Data Sheet 0001 giving properties of solid ceramic parts—Data Sheet 9000 for Rokide coatings. *Coors supplies solid ceramic lining bricks and grinding balls. Most solid ceramic parts can be ordered through your equipment manufacturer. Coors offers process licenses and material so you can do Rokide coating right in your mill.*



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GOODYEAR

Q: What do Goodyear Earthmover Rims have that no others have?

A: MORE times FOUR

1. MORE rims on the job: More tons are hauled on—more earth-moving equipment rides on Goodyear rims than on any other kind. Result: You reap the benefits of the widest, soundest experience in rim design, manufacture and use.

2. MORE kinds of rims: Maximum rim performance stems from proper specification. Goodyear makes the *only complete line* of earthmover rims. Result: The choice that permits you to get exactly the right rim for the job.

3. MORE rim engineering help: Goodyear has more engineers designing *and selling* rims than any other company. And they know tires, too. Result: The help you need in choosing the right rim for top performance—longer tire life.

4. MORE rim "firsts": The first *true* earthmover rim, the first 5° rim, the first tubeless rim—in fact, every major earthmover rim advance was made by Goodyear. Result: The very latest in rim design and manufacture at work, for you.

What better reasons for choosing Goodyear as your rim supplier? Only these: The desire and ability to design and build any rim that may be needed for *tomorrow's* earth-moving equipment. No matter what your rim needs or plans, you'll find it pays to call on Goodyear. See your local rim distributor, or write: Goodyear, Metal Products Division, Akron 16, Ohio.

Lots of good things come from

GOODYEAR

THERE'S NO EASIER DRILL TO RUN THAN A REICHdrill!

This smooth operating, all-hydraulic rotary rig is helping REICHdrillers set higher footage records

In blast holing, prospecting and coring, there's no easier drill to run than a REICHdrill. And the key to money making drilling records is a simplified *control "console"*. From it, every move required by an experienced driller . . . every decision he makes . . . is converted smoothly, instantly, by the all-hydraulic system, into positive, time-saving performance.

Hydraulic drive to drill stem eliminates power loss . . . transmission troubles . . . kelly and rotary table.

Vari-speed Hydraulic Drill Control gives the operator the right combination of rotary speed and feed pressure for every formation . . . leveling jacks, mast raising cylinder and barrel loader are hydraulic too!

Other features: fast, easy set-ups; mast inclines for angle drilling; CP heavy-duty compressors; CP Air-Blast Bits for extra footage in toughest formation. *You get more from your rotary when it's a* REICH*drill!*

For further information write:

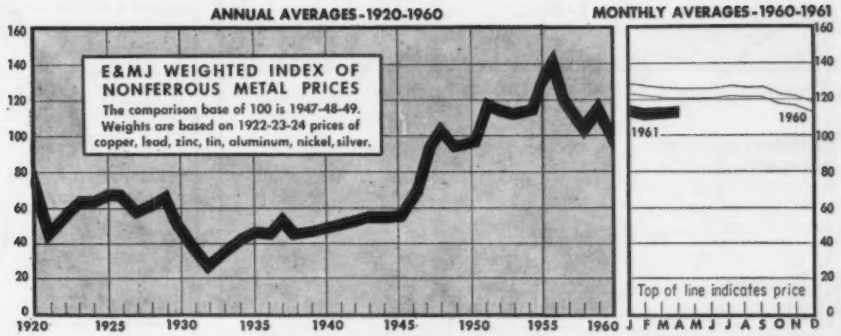
REICHdrill
FRANKLIN (VENANGO COUNTY), PENN.
Division: CHICAGO PNEUMATIC TOOL CO.

T-650 truck mounted REICHdrill operating in an Indiana quarry. Hole size: to 7-7/8"; down-pressure: to 30,000 pounds. Other models available, trucks or crawler mounted with hole sizes to 16" down-pressure to 90,000 pounds.

Positioned at control "console", REICHdriller has every rig maneuver in sight . . . every rig control in reach.

E&MJ OUTLOOK

PRICES


ANNUAL AVERAGES-1920-1960
MONTHLY AVERAGES-1960-1961
E&MJ WEIGHTED INDEX OF NONFERROUS METAL PRICES
The comparison base of 100 is 1947-48-49. Weights are based on 1922-23-24 prices of copper, lead, zinc, tin, aluminum, nickel, silver.
1960
1961
Top of line indicates price
J F M A M J J A S O N D

MARKETS

Metal prices appear to be moving out of a trough which started with a dip in July 1960 and culminated in a low in February 1961. E&MJ's nonferrous metals price index rose for the second month in a row, increasing from 115.4 for March to 115.8 for April. Higher tin prices were responsible for the recent rise.

Resurgence of activity in steel and automobiles, plus pressures for higher prices in the copper market are expected to drive the index higher next month.

•

AT HOME

First commercial application of the fuel cell will probably be in the plant of a company producing waste hydrogen. Progress in development of commercial cells appears to be much faster than expected several years ago. Allis-Chalmers, for instance, reports that since it has built the first fuel-cell-powered tractor, efficiency of the cell has been increased by 1,800%. A 20-hp tractor can now be powered by a fuel cell one-third the size of the original demonstration model.

There will be a 32% general increase in lead requirements for battery production by 1976, according to C. H. Allen, president of the American Battery Manufacturers. This forecast is based in part on estimates by the U.S. Bureau of Public Roads that automobile registrations will jump from the current level of 73,900,000 vehicles to 113,642,000 cars by 1976.

•

LABOR

A 32-hr week is the next target on the Mine-Mill strategy committee's agenda. The Union says that it will work for the shorter work-week without loss in take-home pay. See p 21.

•

ABROAD

Sherritt Gordon Mines, Ltd., Toronto, Canada, has purchased the U.S. Government stockpile of some 3,500 tons of nickel-cobalt calcines at Fredricktown, Mo. Calcines run about 19% nickel and 13% cobalt. Calcines will be treated at the company's nickel and cobalt refinery at Fort Saskatchewan, Alberta, Canada.

Latin American nationals report that U.S. aid programs will do little good to avert Castro incidents unless Latin American citizens themselves do a better job of creating opportunities for poverty-stricken masses to improve their status. International economic and political patterns in many Latin American communities virtually preclude the development of a middle-class society—a prime essential to non-communist governments.

Anaconda Co. has discovered a 50-million-ton copper oxide orebody averaging about 1% copper near the Chuquicamata open-pit copper mine. Charles Brinckerhoff, Anaconda president, reported that if the new deposit can be mined economically, production will prolong life of the present oxide treatment plant at Chuquicamata substantially.

THIS MONTH IN MINING

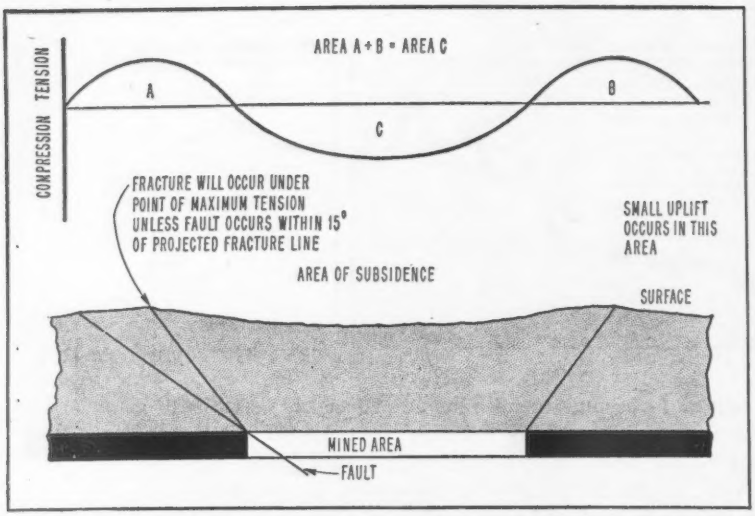


FIG. 1 By graphing surface changes in compression and tension, areas that will be affected by additional subsidence and fracture can be determined.

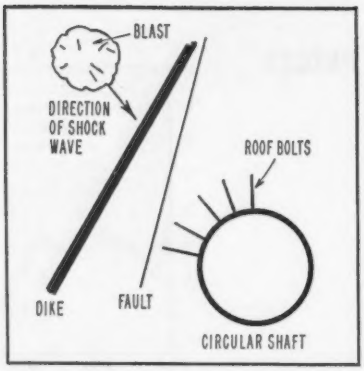


FIG. 2 Dikes, faults and roof bolts protect openings from blast shock waves.

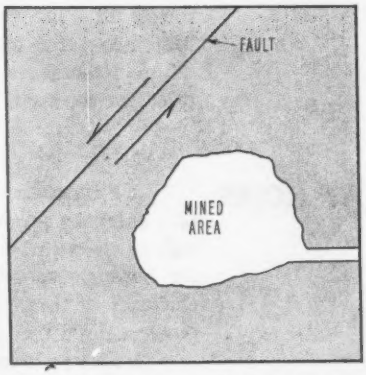


FIG. 3 Mining may reactivate faults by reducing resisting forces on one side.

Rock Mechanics Symposium Charts Progress

ROCK MECHANICS, a subject intensively researched for the last 10 years, is reaching a useful stage of development, as was brought out in the Fourth Symposium of Rock Mechanics at Pennsylvania State University, March 30 to April 1, 1961. The objects of rock mechanics are: (1) to predict rock movement, and (2) to relate underground structural design to rock pressures.

The civil engineer, working with uniform materials, can analyze the physical properties of those materials and predict with a fair degree of accuracy what will happen to those materials under various stresses. The mining engineer, on the other hand, is working with so many variable materials and structures that good predictions are difficult to make. Yet, some engineers are now making predictions with a fair degree of success.

Dr. John Reed and C. David Mann pointed out in E&MJ, March 1961, that simple convergence measurements in underground openings are enough, when made at regular time intervals, to indicate when the ground is in danger of failing. Dr. Bertrand Schwartz, director of the School of Mines, Nancy, France, made roughly the same observations at the Symposium.

Dr. Schwartz also observed that, for some mines, two measurements are all that is needed to project convergence against time. Thus, the engineer will know at what time convergence is great enough to cause failure. Schwartz's ideas have proved practical in longwall coal mines in France overlaid by bedded deposits, where the working area was unaffected by other mining. Dr. Schwartz also determined, by the calculation of stresses, that these mines could reduce the density of support frames underground and save money. The reason is that even by increasing the density of frames to three times its number, the resistance is still very small in comparison to the ground forces.

Another idea brought out by several speakers at the Symposium is that measurements of compression and tension at the surface will indicate where subsidence will occur as well as where lines of fracture will occur (Fig. 1). Don U. Deere cited one example where such information was used to locate surface structures so as to be unaffected by the subsidence. Subsidence occurs along the area of compression while fractures occur at the area of maximum tension.

Dr. Schwartz modified this idea during one discussion by saying that if a fault occurred within 15° of the point of maximum tension and the mined area, the fracture would occur along the fault; otherwise, the fault would have no effect. When one considers that whole towns have been lowered as much as 5 ft in Europe without damage to surface structures, one can appreciate the practicability of such concepts.

E. de St. Q. Isaacson, consultant, Bombay, India, explained methods used in the Kolar Gold Fields to protect shafts from shock waves resulting from blasting or ground movement (Fig. 2). Isaacson believes the energy content of the blast is the most important factor in predicting its damaging effects.

Based on the theory that a reflected shock wave causes failure in tension around underground openings, certain protective measures have been taken—both support and design measures. Isaacson stated that if a fault or dike occurred between the shaft and the blast, they would act as reflectors of the shock wave and little or no damage would occur to the shaft. Consequently, some shafts have been designed to take advantage of these protective barriers.

Two methods of protecting the shaft from blasting are (1) placing rock bolts around the affected area (Fig. 2) and (2) placing unconsolidated material between the shaft lining and the rock. The latter method is considered unsatisfactory because the material consolidates in time.

An interesting theory to explain underground fault movement which in turn causes transmission of high energy shock waves and subsequent rock bursts was explained by Isaacson (Fig. 3). Originally, forces along one side of a shear plane (fault) exceeded resisting forces on the other side, and movement occurred. The movement stopped when the forces were equalized. However, if material is removed by mining, the force on the mined side will be changed, and additional movement along the fault plane is likely to occur.

Papers given at the Symposium were divided into four sections: (1) Strata Movement From Underground Openings, (2) Behavior of Rock Under Static Loading. (3) Behavior of Rock Under Dynamic Loading, and (4) Stress Measure-

ment and Ground Control. Theories were advanced attempting to explain rock strength and failures by atomic bonding, grain size, "Griffith" cracks, fracture patterns, and stress waves and by relating many of the various physical properties of rocks. Many techniques to measure ground stresses, their directions and sources, were also explained. All papers will be published at a later date.

Symposium members were shown movies, taken at 5000 to 7000 frames per second, of drag-bit cutting of limestone, sandstone and shale by Carl Gatlin of the University of Texas. In slow motion, the action was analogous to the whittling of wood, with cracks developing in the rock from the bit bottom to the rock surface. The elliptically shaped particles broke away from the bit surface so that the bit was not in contact with rock at all times. Only the extreme lower portion of the bit was actually ever in contact with the rock. It is believed that studies of this type can result in better bit design.

Chilean Mine Department Outlines Small Mine Policy

CHILE's Secretary of Mines Serrano, for the first time since the present government was inaugurated more than two years ago, made public Chile's policy on medium and small mines at a meeting of the National Mining Enterprises Board. New plans include a revised mining code, improved technical education, more geological surveys, aid to small miners and federal agency mergers. Serrano voiced some opinions on copper economics, leading off with this fact: Chilean copper consumption now grows about 3% annually, meaning that by 1970 the present need for 3.6-million tons per year will have jumped around 40% to 5.2-million tons.

Chile can expect, Serrano noted, a greater price stability on copper at a more profitable level. Right now a 1¢ change in price represents a $6-million a year difference in revenue and $11-million in Chile's total take from copper sales. To add to mineral resource advantages, he said raw materials should be processed in the countries that produce them, and Chile feels that the increasing number of refineries in Africa, Canada and the U.S. proves this tendency.

With an eye on the future, Serrano expects to push these improvements for the small miners:

1. Merger of federal agencies involved with mining.
2. Rewriting the mining code, as well as revising laws on mine taxation and introduction of foreign capital.
3. Improving technical education, with emphasis on Chilean mining history.
4. Initiating more—and better—geological surveys to determine mineral wealth.

(*Continued on p 118*)

As We Went to Press . . .

Sherritt Gordon Mines Ltd. has announced the purchase of 3500 tons of nickel-cobalt calcines from the GSA stockpile at Fredericktown, Mo. for approximately $700,000. The calcines contain about 19% Ni and 13% Co.

The calcines were produced as a by-product at the U.S. Government-operated refinery at Flat River, Mo. from war-bought copper-lead ores. They were declared in excess of U.S. needs in January.

Sherritt Gordon will move the material to the nickel-cobalt refinery which it operates at Fort Saskatchewan, Alberta, on ores from the Lynn Lake deposit. The metal produced will contribute to Fort Saskatchewan's output of nickel and cobalt strip, wire and rod. Purchase of the calcines will guarantee a supply for cobalt production, which was lacking in supply.

Congressman Walter S. Baring has introduced a new gold bill, HR 6281, which would amend the Internal Revenue Code by increasing the percentage rate application to domestic gold ores "for purposes of the deduction for depletion, thereby raising the present 15% depletion allowance to 100%."

The Nevada Representative noted that passage of the bill would not only attract venture capital to an extent "never before paralleled," but would improve employment, help maintain and increase mining and exploration manpower, permit the development of tax-supporting communities in undeveloped areas and put gold back into the U.S. Treasury.

"I will continue my efforts to increase gold production in this country," the Congressman said, "and also to restore our defunct mining industry."

Frank R. Milliken, former executive vice president of Kennecott Copper Corp., has been named president and chief executive officer of the company. He succeeds Charles R. Cox, who is retiring, but will remain a member of the board and of the executive committee.

Mr. Milliken is a metallurgist, and returned to Kennecott in 1952 after serving as plant manager at National Lead's MacIntyre development Tahawas, and as assistant manager of National Lead's titanium division.

Hanna Nickel Smelting Co., subsidiary of the Hanna Mining Co., has exercised its option to purchase the nickel smelter at Riddle, Ore. from the U.S. Government and will go into commercial marketing of ferronickel. Hanna has operated the plant since 1955, using the Ugine process on ores from the company's Nickel Mountain Mine, about 1½ miles from the plant. Handling 1.5% Ni ore, the plant produced 11,000 tons in 1960. All production since 1955 has gone into the U.S. stockpile and now, with the delivery of the equivalent value of $20-million, Hanna owns the plant.

With 51% of its ownership in Mexican nationals' hands, a new company, Metalurgica Mexicana Penoles, S.A., has been formed to continue the mining, smelting and refining operations formerly run by American Metal Climax in Mexico. The board of directors will be equally divided between Amax officers and representatives of the Mexican ownership.

The new company is planning a new zinc plant at Torreon and a sodium sulphate plant at Laguna del Rey, where it holds mineral claims.

WASHINGTON IMPACT

Highlights

PRESIDENT KENNEDY WANTS TO STIMULATE plant and equipment modernization in all industries, including mining. He has sent Congress a tax credit proposal designed to spur spending in this area.

The Administration has recognized for some time that heavier spending on plants and equipment is needed to help get U.S. business out of a short-term slump and into a long-term rise. The debate has centered on the method of tax incentive which should be adopted.

Kennedy has decided on the Surrey approach of tax credits—so called for Assistant Secretary of Treasury Stanley Surrey. The idea is to allow businesses to deduct from their final tax bills a set percentage of money spent in the taxable year on plant and equipment modernization.

An alternative approach is an increased depreciation allowance.

Here is the plan Kennedy has asked Congress to approve:

Companies, individuals, and partnerships would be allowed to deduct from their final tax bill an amount up to 30% of their tax-year expenditures after Jan. 1, 1961. A taxpaying company can deduct the total of these credits: (1) 10% of the first $5,000 of spending on new plant and equipment, without regard to depreciation allowances; (2) 6% of all plant and equipment spending in excess of 50% of the depreciation allowance, but not more than 100% of the allowance; and (3) 15% of the spending that is in excess of the same year's total depreciation allowances.

There are some limitations and eligibility features for the special tax credit. Maximum reduction is 30% on expenditures after next Jan. 1. Expenditures qualify only for new, not used, plant and equipment. The facilities must be located in the U.S. and not abroad. The tax plan applies only to assets with a tax life of six years or more.

Kennedy's tax plan requires Congressional approval, and there is strong sentiment in Congress to stick with depreciation allowances rather than a new tax formula to increase plant and equipment spending. The backers of increased depreciation allowances may be sufficient in number to beat down the Kennedy Plan.

BUT THE ADMINISTRATION'S tax package has some carrot-and-stick aspects. While plumping for tax deductions on equipment spending, the White House also wants to crack down on business-expense deductions.

Kennedy would repeal provisions in the tax code which allow deduction of business entertainment "of a personal nature." Night-club entertaining, for example, would be stricken. He would also bar deductions for certain entertainment facilities—especially yachts and hunting lodges.

Restrictions would be imposed on the deductability of business gifts, combined "work-and-play" vacations and business trips. "Excessive living expenses" in business travel would be curbed.

THE INTERIOR DEPARTMENT is working on its own plan to stabilize U.S. production of metals and minerals, a plan aimed specifically at direct subsidization of smaller lead and zinc producers.

Secretary of Interior Stewart Udall has not detailed his program, but he expects to include some form of Government aid. But the program will be broad and not based entirely on subsidies.

The Interior Department planning is pulling the rug from under Congressional advocates of subsidies for smaller producers of lead and zinc. The Kerr-Edmondson bill, for example—passed by Congress in 1960 but vetoed by President Eisenhower—probably will not clear either the House or Senate this year because of opposition from the Interior Department. Administration officials see the Kerr-Edmondson plans as too narrow and short-term a solution.

Meanwhile, the Administration has moved to reduce world production of lead by offering to exchange U.S. surplus agricultural commodities for promises by world producers to cut back 1961 production and stock-piles.

Government officials have set a deadline of May 15 for lead producers to accept the barter deal. They also have made clear that the offer—made previously in 1960—will not be renewed.

House Subcommittee Plans Import Damage Studies

A HOUSE Labor Subcommittee is planning an investigation of the impact of imports on U.S. production and employment. Three major metals—copper, lead and zinc—are scheduled to be considered in the study.

The subcommittee will be headed by Rep. John H. Dent (D., Pa.), a longtime critic of import competition with U.S. industries. Other members include Rep. Cleveland M. Bailey (D., W. Va.), and Rep. Carrol D. Kearns (R., Pa.).

Although much of the committee's attention is expected to be directed to home-state commodity troubles—coal, steel and other products—members say they also want to hear testimony on metal-mineral imports and their effect on domestic competition.

The subcommittee hearings are expected to set the stage for an attack on the Reciprocal Trade Agreements program when it goes before Congress for reviewal in 1961.

First hearings by the subcommittee are expected to be held in the summer, probably following Congress' adjournment.

Cuban-Held Properties Will Stay That Way

U.S. MINING properties in Cuba probably will not be returned easily or quickly to U.S. ownership even if the Castro regime is toppled.

Administration officials expect the rebel group opposing Castro, if it succeeds to power, to hew closely to nationalization lines. Most of the leaders of anti-Castro forces are Cubans who originally supported the Castro revolution, then broke with the premier.

U.S. diplomats, in the event of a Castro overthrow, would be extremely reluctant to press for return of the seized Cuban properties to U.S. owners.

Considerable time would have to elapse, most officials believe, before any negotiations could begin for reparation payments or return of any property.

Brass Fabricators Receive Subpoenas

THE JUSTICE DEPARTMENT has started its Federal Grand Jury investigation of brass industry pricing practices in Hartford.

A number of witnesses from brass-fabricating firms have been subpoenaed, along with company documents.

Government attorneys do not expect the Grand Jury investigation to be extended to production phases, but do not rule out the possibility that the inquiry may at some point be extended beyond sales and pricing.

GSA Asks for Bids to Convert Molybdenite

THE General Services Administration plans to upgrade more of molybdenite in the national stockpile of strategic and critical metals.

The Government agency is asking for proposals to convert molybdenite to higher use forms of molybdic oxide and ferromolybdenum.

Under present upgrading, GSA requires a molybdic oxide that would contain 2.6-million pounds of molybdenum, and the ferromolybdenum, 1.4-million lb of the element.

GSA will accept proposals until May 15.

Interior Adds to OME List; Ankeny Is Re-Named

THE Interior Department plans to add six minerals to the list eligible for exploration assistance from the Office of Minerals Exploration.

New additions proposed are gold, silver, iron ore, bismuth, sulphur, and tellurium.

In a parallel action, the Department also plans to increase from 50% to 75% its maximum payments of exploration costs for critical mineral commodities, including asbestos, beryllium, chromite, and mica.

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MARLING J. ANKENY will continue as director of the Interior Department's Bureau of Mines.

Secretary of Interior Stewart Udall has asked Ankeny to remain in the job which he assumed during the Eisenhower Administration.

Ankeny has been an Interior Department employee for 28 years and was first named to head the Bureau of Mines in 1956.

Secretary Udall also has announced that Dr. Thomas B. Nolan will continue as director of the Department's geological survey.

Nolan, a tungsten specialist who has been in the department for 37 years, became head of the geological survey in 1956 after having been appointed assistant director in 1944.

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THE COMMERCE DEPARTMENT is making available a new manual for prospectors telling where and how to find beryllium.

The manual, compiled by the Defence Metals Information Center, is designed to help meet the need for greater supplies of beryllium for nuclear and space-age technology.

Information in the manual is especially designed to add prospectors and others concerned with the search or application of the metal.

The 30-page report, entitled "Manual for Beryllium Prospectors," can be ordered from the Office of Technical Services, Department of Commerce, Washington, D.C., for $1.

Labor This Month

MINE-MILL STRIKE FUND LOOMS: With an eye of industry-wide negotiations in 1962, members of the International Mine-Mill and Smelter Workers Union vote this month on a sizable boost in their strike fund. Delegates to the union's 56th national convention approved the vote on a 75¢ increase in monthly dues—with one-third of the increase to be set aside for the fund. Up to now, the fund has been supported by a 5¢-per-month payment from each member.

Mine-Mill officers will also be picked in the referendum voting. Up for re-election to new two-year terms are candidates John Clark for president, Asbury Howard for vice-president and Irving Dictor for secretary-treasurer—all unopposed. There is one contest. Vice president A. C. Skinner of Salt Lake City is opposed by Ernest Salvas of Butte, Mont., currently a district board member.

TARGET NO. ONE—32 HOUR WEEK: This is the top demand laid out by Mine-Mill's strategists for its next big bargaining sessions with the non-ferrous industry next year. The union says it will work for the shorter work-week "Without loss in take-home pay . . . in Congress, in the next negotiations and anywhere a gain can be made . . ." While Mine-Mill picks 32 hours, the AFL-CIO wants Congress to shorten the work week to 35 hours and Walter Reuther's United Auto Workers may ask the 30-hour week in this summer's auto negotiations.

TOO MANY JOBS—THE NEW THREAT: The machinists' union, which shares the union push for the shorter-work-week, warns that it may bring new troubles. "Moonlighting"—the union term for holding more than one job—is already a "serious threat," say machinist officers. "It is indeed ironic," the union adds, "That the 40-hour week has made it possible for some workers to take additional employment . . . at the expense of other workers.

U. S. METALS PROTECTION, ACROSS-THE-BOARD: Increasingly concerned over job losses in the non-ferrous metals industry, Mine-Mill has spelled out a package of protection for the industry. MMSW, in action by its international convention, proposes these goals:

- Establishment of a United Nations Metal Bank for stockpiling metals to use in under-developed countries.
- Federal subsidies on newly mined copper, lead and zinc that would assure mine producers a return of 27.5¢ per pound on 1-million tons of copper; 15¢ per lb. on 350,000 tons of lead; 14¢ per lb. on 550,000 tons of zinc.
- Adequate tariff protection for brass to restore 2500 jobs in American brass mills which would also "Give important assistance to the U. S. copper mining industry."

PROBING NATIONAL EMERGENCY STRIKES: Although the Kennedy administration is lukewarm about it, House Labor Committee chairman Adam Clayton Powell intends to investigate Taft-Hartley rules for handling major industrial strikes. President Kennedy and his Secretary of Labor, Arthur J. Goldberg, once advocated changing the law but now prefer to let the President's Labor-Management Advisory Committee handle the subject. Powell, however, will go ahead with committee hearings on new ways to curb such strikes. Powell wants greater White House authority to terminate critical walk-outs. The President currently is limited to seeking a 90-day strike-ending injunction. Powell will look into seizure, fact-finding, compulsory arbitration and other methods to give the President a full arsenal of anti-strike weapons.

LABOR UNIT—COMING OR GOING? While officials of the Independent Mine-Mill Union issue the call for a single alliance of labor unions, the merged AFL-CIO seems to be going in the opposite direction. Feuding between the AFL-CIO's craft and industrial unions has reached a fever pitch. The battle sites are industrial plants where they are contesting every construction job; in Congress where they openly disagree on Taft-Hartley legislation; in the courts where they are on opposite sides of legal tests growing out of their fight over work assignments.

MARKETS

Copper Market Stiffens; London Prices Higher; Aluminum Stocks Sliced; Tin Market on the Rise

THE E&MJ INDEX of Nonferrous Metal Prices picked up .4% in April and settled at 115.8% of the 1947-49 average, with the rise based solely on the increased price of tin. The April tin average was nearly 4c higher than the previous month. The other more heavily weighted average showed no change.

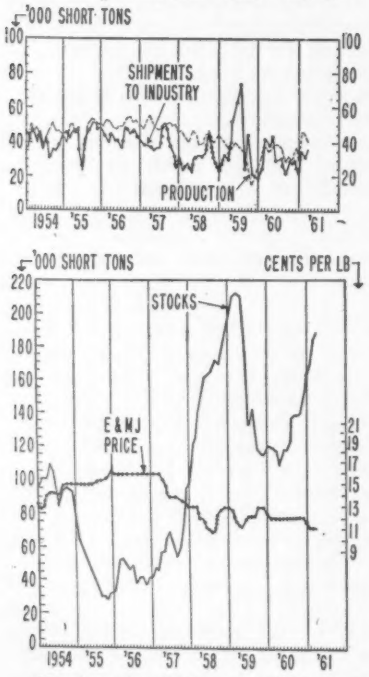
The E&MJ Index of Metal Use for April, adjusted for seasonal variation, is estimated at 100% of the 1950 average. Both the February final and the March preliminary figure have been revised downward to 99%.

April ended with many observers in the copper market openly predicting a boost in the 29c primary quotation, maintained by producers and custom smelters since the beginning of the year.

The belief was that the move would be initiated by one of the smelters.

On the final day of the month London prompt bid rose to £234¼ (29.28c) and for the first time in months exceeded the U.S. price. With tariff and shipping charges it would cost a buyer here close to 32c to import copper. It can be expected that if the London price continues to rise, more and more metal will be lured in that direction.

Primary Refined Lead Data



The above data, in thousands of short tons, are from the American Bureau of Metal Statistics. They refer to the total amounts of refined lead as reported by all primary refiners in the U. S. Some secondary lead is included. "Shipments to industry" includes exports. Data are through March.

World-wide output curtailments continue with only Kennecott Copper Corp. loosening its position. The company, faced with a possible strike at the end of June and increased demand, has increased its domestic work week from six to seven days. The strike consideration concerns the entire industry. Meanwhile the market can look forward to a less-than-normal supply.

Domestic sales both flat and average soared here in April. Reports to E&MJ for the month were the highest since May, 1959, and heavy average sales by smelters, hedging a price rise, added heavily to the industry total. Domestic fabricator statistics lent additional strength. March figures showed that shipments of copper contained in fabricated products rose nearly 20,000 tons with bookings for future delivery rising about 11,000. Stocks fell a little more than 3,000 tons.

As May began, Asarco increased its U.S. price 1¢ to 30¢ a lb delivered. Anaconda, a producer, followed the custom smelter move, and the rest of the industry was expected to go along.

The tin market climbed wildly in April with prices hitting £844 in London and 109¾c here, the highest level since the Suez crisis in 1956. Spreading belief that a world shortage was developing was aggravated by word that Congo output had been cut off.

Consumer demand in London and the East has been running strong, but U.S. platers, covered through the canning season, have shown resistance to inflated prices. The outlook is for a decidedly higher price level than in recent months. The Buffer Pool manager has been selling—he's permitted to at above £830 and must at £880—but the basic threat of a 1961 shortage remains. These sales and profit taking by speculators have temporarily halted the price ascent. Some look for the £880 plateau to be reached by mid-summer.

The aluminum industry got a statistical boost during the month when U.S. Bureau of Mines data showed industry stocks had been cut 4000 tons from a record 291,000 at the end of January. A combination of improved shipments (142,500 from 129,500 tons) and lower output brought about by industry cutbacks did the trick.

Primary output was up in March, according to the Aluminum Assn., but the percent of operating capacity dipped owing to additional work days in the month and increased industry capacity. March output was 152,022 tons, 72.1% of capacity. February was 138,560 tons and 73.2%.

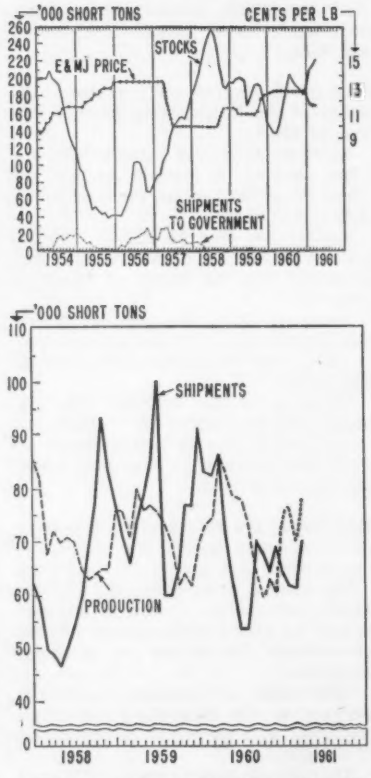
Market sentiment is mixed concerning the short term future of the aluminum market. Some feel an upturn and are ready to talk about it; others are pessimistic and see only heavy stocks, idle capacity and proposed new capacity. Kaiser for one has taken definite action. In April the company returned three potlines (Ravenswood, Mead, Chalmette) to production and jumped its percent of operating capacity from 50% to 65%.

The zinc market appears rejuvenated at the moment. Severe domestic cutbacks and improved buying here have been the tonic. Prime Western sales for galvanizing continue to set the pace, but other grades have moved beyond expectation. Were auto production on schedule, the market would be in even better shape. The 11½c price appears secure and should move up with the U.S. economy.

N.J. Zinc Co. further curtailed slab output at its Palmerton, Pa. and Depue, Ill. smelters and closed down its Flat Gap mine in Treadway, Tenn.

Lead sales during the month continued at a satisfactory but unspectacular pace. The Department of Agriculture is expected to announce the addition of lead to its barter list shortly. Cutback proclamations from countries attending the recent lead-zinc meeting in Mexico City have been slow in coming. The U.S. price is expected to hold in the near future.

U.S. Slab Zinc



The above data, except price, are from the American Zinc Institute and are in thousands of short tons. They refer to slab zinc of all regularly operating United States primary and secondary smelters. Data include March.

Average Prices April (E&MJ Quotations)

Cents per lb unless otherwise indicated:

Copper:	
Electro, domestic refinery	28.600
Electrolytic, exports refinery ..	27.781
Electrolytic, c.i.f. Cont'l ports .	28.726
Lead:	
Common, New York	11.000
Common, St. Louis	10.800
Silver:	
Silver, New York, per oz.	91.375
Silver, London, pence per oz. .	79.559d
Zinc:	
Prime, Western, East St. Louis	11.500
Prime, Western, delivered (g) .	12.000
Tin:	
New York Straits	107.219
Gold, per oz,, U.S. price ...	$35.000
Sterling Exchange	279.805
Quicksilver, per flask	$205.900
Antimony, (E&MJ) (d)	36.250
Antimony, bulk, Laredo ...	32.500
Antimony, in cases, Laredo .	33.000
Antimony for, 99% (h)	28.125
Palladium, troy oz	$24.000
Platinum, refined, per oz. ..	$82.000
Cadmium (a)	160.000
Cadmium (b)	170.000
Al, 99½% unalloyed ingot .	26.000
export, ingot	23.250
Magnesium, ingot	35.250
Nickel, (f)	74.000
Bismuth	$2.250
Cobalt	$1.500

Domestic quotations, unless otherwise stated are in cents per lb. Sterling exchange checks, in cents. Quick-silver per flask of 76 lb.
(a) Per lb delivered, ton lots.
(b) Per lb delivered, small lots.
(d) Domestic 5 tons or more but less than carload lots, packed in case f.o.b. New York.
(f) Contract price, f.o.b. Port Colborne U.S. duty included.
(g) Delivered where freight exceeds 0.5c.
(h) 2c duty extra.

Free Gold Market

The volume of international gold dealings rose 4% in April. Events in Cuba and Algeria caused increased hoarding demands. Bar gold prices were up fractionally, while coins gained 1% to 2% in leading centers. London and Paris continued as the most active markets. The Soviets sold about 31 tons of the yellow metal in Paris and additional sales are expected in the months to come. Gold futures transactions rose to unexpected high levels of $1 to $2-million daily towards the end of the month. Interest rate for one-year delivery listed at 4¾% p.a. against dollars to 5½% p.a. against Swiss francs. U.S. gold stock increased by 1-million to $17.390-billion. PICK'S WORLD CURRENCY REPORT quotes on "free gold" per fine oz as follows:

	Coins		Bars (12.5 kg)	
	Mar. 31	Apr. 30	Mar. 31	Apr. 30
New York transit	.....	.....	$35.10	$35.10
Manila	$41.00	$41.25	35.80	35.90
Hong Kong	47.60	48.35	39.85	39.00
Bombay	56.75	56.60	53.50	53.50
Beirut	40.65	40.75	35.25	35.285
Paris	40.00	40.40	35.35	35.50
Buenos Aires	41.35	41.40	36.25	36.45

Note: Prices are quoted at the free or black market value of the U. S. dollar in the local markets.

Custom Smelter Copper

Based on flat price and E&MJ average price sales in U.S. for month of April reported by American Smelting & Refining Co. electrolytic copper in standard shapes, adjusted to nearest ⅛¢; ¼¢ deducted for selling common.

Delivered consumer's plant..28.750 lb
F.o.b. refinery .....28.350 lb

Major Metals

U.S. DAILY AND AVERAGE PRICES

Cents per lb unless otherwise indicated:

Apr. 1961	Electrolytic Copper (a) Domestic	(b) Export	Europe c.i.f. (e)	Lead New York	Lead St. Louis	Zinc (f) Delivered	Zinc East St. Louis	Aluminum Unalloyed Ingot 99%	Straits Tin New York
3	28.600	28.175	29.120	11.000	10.800	12.000	11.500	26.000	104.625
4	28.600	27.350	28.295	11.000	10.800	12.000	11.500	26.000	104.625
5	28.600	27.425	28.370	11.000	10.800	12.000	11.500	26.000	104.500
6	28.600	27.525	28.470	11.000	10.800	12.000	11.500	26.000	105.000
7	28.600	27.375	28.320	11.000	10.800	12.000	11.500	26.000	105.500
10	28.600	27.525	28.470	11.000	10.800	12.000	11.500	26.000	106.750
11	28.600	27.800	28.745	11.000	10.800	12.000	11.500	26.000	108.500
12	28.600	28.025	28.970	11.000	10.800	12.000	11.500	26.000	109.750
13	28.600	28.000	28.945	11.000	10.800	12.000	11.500	26.000	109.000
14	28.600	27.825	28.770	11.000	10.800	12.000	11.500	26.000	107.750
17	28.600	27.700	28.645	11.000	10.800	12.000	11.500	26.000	107.000
18	28.600	27.750	28.695	11.000	10.800	12.000	11.500	26.000	107.125
19	28.600	27.825	28.770	11.000	10.800	12.000	11.500	26.000	107.500
20	28.600	27.750	28.695	11.000	10.800	12.000	11.500	26.000	108.250
21	28.600	27.800	28.745	11.000	10.800	12.000	11.500	26.000	108.375
24	28.600	27.850	28.795	11.000	10.800	12.000	11.500	26.000	108.250
25	28.600	27.875	28.820	11.000	10.800	12.000	11.500	26.000	108.125
26	28.600	27.875	28.820	11.000	10.800	12.000	11.500	26.000	108.000
27	28.600	27.950	28.895	11.000	10.800	12.000	11.500	26.000	107.875
28	28.600	28.225	29.170	11.000	10.800	12.000	11.500	26.000	107.875
AVERAGES FOR MONTH									
Apr.	28.600	27.781	28.726	11.000	10.800	12.000	11.500	26.000	107.219
AVERAGES FOR WEEK									
Apr.									
5	28.600	27.515	28.460	11.000	10.800	12.000	11.500	26.000	104.594
12	28.600	27.650	28.595	11.000	10.800	12.000	11.500	26.000	107.100
19	28.600	27.820	28.765	11.000	10.800	12.000	11.500	26.000	107.675
26	28.600	27.830	28.775	11.000	10.800	12.000	11.500	26.000	108.200
CALENDAR WEEK AVERAGES									
Apr.									
7	28.600	27.570	28.515	11.000	10.800	12.000	11.500	26.000	104.850
14	28.600	27.835	28.780	11.000	10.800	12.000	11.500	26.000	108.350
21	28.600	27.765	28.710	11.000	10.800	12.000	11.500	26.000	107.625
28	28.600	27.955	28.900	11.000	10.800	12.000	11.500	26.000	108.025

THE above quotations for major nonferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis. All prices, except gold and silver, are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered U.S. basis add 0.400c per pound, the average differential for delivery charges.

(b) Export copper daily quotations are weighted averages based on sales outside the U.S. reported to E&MJ. Ocean freight and 0.125c lighterage and handling are deducted to arrive at the f.o.b. Atlantic seaboard refinery quotation. On f.a.s. U.S. sales lighterage of 0.125c is deducted.

(c) The daily silver quotations reported by Handy & Harman, in cents and fractions of a cent per troy ounce, is the price paid by Handy & Harman in settlement for silver contained in unrefined silver-bearing materials submitted to them for refining. It is determined on the basis of offers of bar silver .999 fine as made to Handy & Harman for nearby delivery at New York by regular suppliers in quantities sufficient to meet daily requirements, and it is usually 0.250c below the price at which such offers are made.

The Treasury's purchase price of newly mined domestic silver is 90.5c per troy ounce 1000 fine effective July 1, 1946. London silver in pence per troy ounce, basis .999 fine.

(d) U. S. Treasury's gold price is $35. Actual payment by the United States Treasury for gold is at 99.75 per cent of the price quoted by the Treasury, which is equal to $34.9125.

(e) The c.i.f. Continental ports quotation is arrived at by adding to the f.o.b. export quotation lighterage, and the standard conference freight and insurance, Atlantic ports to main Continental ports. Currently this is 0.125c and 0.82c.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingots; cathodes are sold at a discount of 0.125c to 0.15c per pound. Quotations for zinc are based on Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East, Middle West and West effective Apr. 1, 1960, commanded a premium of 1.50c per pound over the current market for Prime Western; Special High Grade 1.75c effective Apr. 1, 1960.

(f) Prime Western delivered where freight from E. St. Louis exceeds 0.500c.

Quotations for lead are based on domestic common lead. Corroding lead commands a premium of 10 points (almost all U.S. lead is corroding grade).

Silver, Gold and Sterling

DAILY AND AVERAGE PRICES

Apr. 1961	Silver (c) New York	London	Sterling Exchange	Gold (d) London
3	91.375	Holiday	279.8600	Holiday
4	91.375	79.625d.	279.8600	250s. 9d.
5	91.375	79.625d.	279.8820	250s. 8½d.
6	91.375	79.625d.	279.9300	250s. 8d.
7	91.375	79.625d.	279.8640	250s. 7d.
10	91.375	79.625d.	279.9200	250s. 7¼d.
11	91.375	79.625d.	279.9340	250s. 7d.
12	91.375	79.625d.	279.9360	250s. 7¼d.
13	91.375	79.625d.	279.8900	250s. 7¼d.
14	91.375	79.625d.	279.8160	250s. 7¼d.
17	91.375	79.625d.	279.8460	250s. 8d.
18	91.375	79.625d.	279.8840	250s. 7¼d.
19	91.375	79.625d.	279.7660	250s. 7½d.
20	91.375	79.625d.	279.7820	250s. 9d.
21	91.375	79.625d.	279.6560	250s. 9¼d.
24	91.375	79.375d.	279.6025	251s. ⅛d.
25	91.375	79.375d.	279.5640	251s. ⅛d.
26	91.375	79.375d.	279.7780	250s. 10¼d.
27	91.375	79.375d.	279.7300	250s. 9¼d.
28	91.375	79.375d.	279.6060	250s. 10⅛d.
AVERAGES FOR MONTH				
Apr.	91.375	79.559d.	279.805	—
AVERAGES FOR WEEK				
Apr.				
5	91.375	—	279.806	—
12	91.375	—	279.917	—
19	91.375	—	279.840	—
26	91.375	—	279.677	—

Calendar Week Averages: New York Silver: Apr. 7, 91.375; Apr. 14, 91.375; Apr. 21, 91.375; Apr. 28, 91. 375.

MARKETS *(Continued)*

London Metal Exchange Quotations

Apr. 1961	Copper Cash Bid	Copper Cash Asked	Copper 3 Mon. Bid	Copper 3 Mon. Asked	Lead Current Month Bid	Lead Current Month Asked	Lead 3 Mon. Bid	Lead 3 Mon. Asked	Zinc Current Month Bid	Zinc Current Month Asked	Zinc 3 Mon. Bid	Zinc 3 Mon. Asked	Tin Cash Bid	Tin Cash Asked	Tin 3 Mon. Bid	Tin 3 Mon. Asked
3								Holiday								
4	225½	225¾	227½	227¾	65⅝	65⅞	66⅜	67⅛	84	84¼	83¾	84	823½	824½	826½	827
5	226	226¼	227½	227¾	66⅛	66¼	67⅛	67¼	84⅜	84½	84	84¼	823½	824	826½	827
6	226½	226¾	228	228¼	66⅛	66⅝	67⅛	67⅝	84¼	84⅜	84	84⅛	828	828½	830½	831
7	228¼	228½	229	229¼	67	67⅛	67⅞	68⅛	83½	83⅝	83⅛	83½	831	831½	834	835
10	229	229¼	230	230¼	67¼	67⅜	68¼	68½	84¼	84⅜	84	84⅛	836	836½	839½	840½
11	229	229¼	230	230¼	67⅜	67¼	68⅛	68¼	84⅜	84½	84⅛	84¼	834½	835	838½	839
12	230¼	230½	231¼	231½	67	67⅛	68¼	68⅜	84⅜	84½	84¼	84⅜	838½	839	847	847½
13	230¼	230½	231¾	232	66¾	66⅞	67⅞	68	84	84⅛	84	84⅛	843	844	848	849
14	228¾	228½	229¾	230	66½	66½	67¾	68	83½	83¾	83⅝	83¾	836	836½	842	842½
17	227¾	228	229½	229¾	65¾	65⅞	67¼	67½	83½	83¾	83¼	83⅜	834½	835½	840½	841
18	229¼	229¾	230¾	231	66⅜	66¾	67⅞	68	83⅞	84	83⅞	84	837½	838	846	846½
19	229	229¼	230¾	231	67⅛	67¼	68¼	68⅝	83¾	83⅞	83⅞	84	838½	839	847½	848
20	228¼	228½	229¾	230	67⅛	67¼	68⅛	68¼	83½	83¾	83⅝	83¾	842	843	850½	851
21	228½	228¾	230¼	230½	67¼	67⅜	68½	68⅝	83⅜	83⅝	83½	83⅝	843	844	851	851½
24	229¾	230	231½	231¾	67¾	67⅞	69	69⅛	83¾	83⅞	83¾	83⅞	844	845	852	852½
25	229¾	230	231½	231¾	68⅛	68¼	69⅛	69¼	83⅝	83¾	83⅝	83¾	842½	843	851½	852
26	229¾	230	231¾	232	67¾	68	68½	69	83⅝	83¾	83½	83¾	843	844	851½	852
27	232¼	232½	234	234¼	67⅞	68	69	69⅛	83¾	84	83¾	83⅞	840	842	848	849
28	234¼	234½	235½	235¾	68	68¼	69	69¼	83⅞	84	83¾	84	843	844	849	850
Av'g's	£229.158		£230.651		£67.076		£68.220		£83.914		£83.849		£837.342		£843.474	

Prices are for the official a.m. session in pounds sterling per ton of 2240 lb. Copper basis wire bars, lead 99.0%, zinc 98% and tin min. 99.7%.

Miscellaneous Metals, Ores, Minerals

Quotations cover wholesale lots, prompt shipments, f.o.b. New York unless otherwise stated. tons of 2,000 lb unless otherwise noted. st—short ton; lt—long ton; stu—short ton unit; ltu—long ton unit. (p) duty extra.

MISCELLANEOUS METALS

Apr. 30, 1961

Aluminum ingot, 99.9% lb		28c
Antimony, spot, lb. less than carload, in cases		36.250c
In bulk, carload lots, f.o.b. Laredo		32.5c
Imported, 10 ton min. (p), 99% Duty not paid	28c —	28.25c
Bismuth, ton lots, lb		$2.25
Cadmium, ton lots delivered, lb		$1.60
small lots		$1.70
Calcium, lb, ton lots, 98% cast		$2.05
Chromium, 99.8% grade, lb, contract delivered	$1.15 —	$1.19
Cobalt, 97 to 99%, per lb effective 3-1-60		$1.50
Germanium, per gram, 10,000 gram lots	(d)28.15c—(c)(d)	29.95c
Indium, troy oz	$1.35 —	$2.25
Lithium, lb, 98%	$9.00 —	$11.00
Nickel, cathodes, lb (a)		74c
Other sales, regular sellers		74c
Sales by dealers, etc		74c
Magnesium, 99.8% carloads, lb producer's plants, Velasco, Texas, effective Apr 16		35.25c
Palladium, troy oz	$24 —	$26
Platinum, troy oz	$80 —	$85
Quicksilver, flask of 76 lb, 25 flasks or more	$205 —	$208
Selenium, 99 plus %, lb—(Feb. 19, 1958)	$6.50 —	$7.50
Silicon, minimum 98%, carloads, lb		19c
Semi Conductor grade, lb., lump		$360
Tellurium, lb		$4.00
Thallium, 100 lb or more		$7.50
Titanium, 99.3% plus, grade A-1, max. 3% Fe, lb (b)	$1.50 —	$1.60

(a) Effective Dec. 6, 1956; including U. S. duty; (b) Effective Aug. 1, 1959. (c) Delivered; (d) f.o.b. plant.

METALLIC ORES

Beryllium ore, imported, 10% BeO, (b) stu; spot	$32 —	$33
term contracts	$34 —	$34.50
Chrome ore per long ton, f.o.b. cars Atlantic ports, dry: 44% Cr_2O_3 no ratio	(a)$19.75 —	$20.50
48% Cr_2O_3 3 to 1 ratio	$35¾ —	$38
Iron ore, Lake Superior, Lower Lake ports, lt		
Old Range bessemer		$11.85(e)
Mesabi bessemer		$11.60(e)
Mesabi non bessemer		$11.45(e)
Lead (Galena), 80%, Joplin, Mo., ton		$125.16
Manganese ore—Per ltu of Mn basis 48%, nearby positions, subject to premiums and penalties, c.i.f. U. S. ports import duty extra., (n)87c—90c. Long-term contract nominal.		
Molybdenum ore, 90%, per lb of Mo f.o.b. mines		$1.25
Columbium-Tantalum, per lb, combined oxides 10 to 1 ratio	$1.18 —	$1.25
Tungsten ore, per stu of WO_3:		
Foreign 65%, c.i.f. U. S. ports, duty extra	$15.25 —	$15.75
U. S. scheelite, f.o.b. mill	$22 —	$24
Vanadium ore, per lb of contained V_2O_5 f.o.b. mines		31c
Zinc ore, Prime, 60% concentrate, Joplin, Mo., per ton.		$68

(a) Nominal. (b) c.i.f. U. S. ports. (c) Effective 1958 shipping season.

METALLIC COMPOUNDS

Arsenous oxide (arsenic trioxide) lb, in bbl, carload lots N. Y. docks		4c
Cobalt oxide, 72½% to 73½%, per lb, effective Mar. 1, 1960	$1.15 —	$1.18
Copper sulphate, 100 lb. effective 10-12-60		$12.00
Germanium dioxide, gm		16¾c
Molybdic trioxide, technical, per lb of Mo	$1.46 —	$1.47
Imported, including 37c duty	$1.75 —	$2.05

ALLOYS

Ferrochrome 65 to 70%, per lb of Cr, (4-9% C)		28¾c
Ferromanganese, 74 to 76%, per lb shipping point		11c
Ferromolybdenum, 58 to 64% Mo. lb of Mo contained	$1.50 —	$1.82
Ferrosilicon, 50% per lb of Si f.o.b. shipping point		14.60c
Ferrotungsten, 72 to 82%, lb of W contained		$2.25
Ferrovanadium, per lb of V delivered	$3.20 —	$3.40
Silicomanganese, [max., 1½% C, lb contracts		11.6c
Spiegeleisen, per lt. 19-21% grade effective Jan. 22, 1960	$100.00 —	$102.50

NONMETALLIC MINERALS

Asbestos, f.o.b. Canada (Quebec) mines (Canadian funds) ton:			
Crude No. 1	$1,400–$1,725	Paper stock	$120–$142
Crude No. 2	$750–$1,155	Waste	$75– $86
Spinning Fibers	$370– $600	Shorts	$40– $75
Shingle fibers	$180– $220		
Asbestos, f.o.b., Vancouver, B. C. (Canadian funds):			
Crude No. 1	$1,522	Spinning fibers	$470–$787
Asbestos, Vermont, f.o.b. Morrisville:		Shingle fibers	$142–$325
Spinning fibers	$353– $408	Waste, stucco or plaster	$86
Shingle stock	$181– $218		
Paper stock	$120– $142	Refuse or shorts	$41– $75
Barytes, f.o.b. cars:			
Georgia, crude, per ton			$18
Missouri, 94%, $BaSO_4$, per st		$16 —	$18
Crude oil well grade, min. 4.3 sp gr, st (a)			$18
Imported, c.i.f. Gulf Ports, st		$16 —	$18
Bauxite, st, f.o.b. point of shipment: Imported metallurgical, per lt, f.o.b. Br. Guiana, 60% Al_2O_3, 6% SiO_2, 1.25% Fe, 1-1-60			$7.25
Feldspar, bulk ton; f.o.b. plants:			
Potash or soda feldspar, 200 mesh, ceramic grade		$17 —	$20.50
Glass feldspar, white, 20 mesh			$9
Fluorspar, f.o.b. mines, bulk, 72½% effective, ton		$37 —	$41
60% effective CaF_2		$33 —	$36
Acid 97% concentrate, bulk, ton			$45.00
Fuller's earth, f.o.b. Georgia or Florida, ton		$7.00 —	$14.00
Magnesite, per ton dead-burned, bulk, f.o.b. Washington			$46
Mica—Domestic, f.o.b. mines, Punch 7c-12c per lb according to size and quality. Sheet clear 1½x2 in. 70c-$1.10; 2x2 in $1.10 to $1.60; 2x3 in, $1.60-$2.10; 3x5 in, $1.80-$2.30; 3x4 in, $2.00-$2.60; 3x5 in, $2.60-$3.00; 4x6 in, $2.75-$4.00; 6x8 in, $4.00-$8.00. Wet ground, very fine, $140-$155 per ton. Bulk sales, dry ground; $30-$55 per ton. Scrap $20-$30.			
Ocher, Georgia, ton in sacks		$26.50 —	$32.00
Sulphur, Mexican, for use in Mexico, metric ton, f.o.b. mines, depending on location		$21 —	$23
For export f.o.b. vessel, depending on grade		$22.50 —	$23.50
Actual prices received by U. S. producers approximate the Mexican export prices.			
Talc, f.o.b. works, ton:			
New York, purified		$18.00 —	$20.00
Vermont, extra fine			$12.50
Tripoli, Missouri, ton:			
40-mesh, cream colored			$50.00

(a) Some restricted sales at $11.50. (b) Corrected. (c) Nominal.

IRON AND STEEL

Pig iron, gross ton, basic, Valley furnaces		$66.00
Steel, f.o.b. Pittsburgh, billets, net ton		$80.00
Structural shapes, Pa., Ala., etc., 100 lb	$5.30 —	$5.50

Just RIP TIP and POUR

You don't have to mix these new economy blasting agents

DU PONT NILITE® 101 AND 202

The minute you tear the corner off your first 50-lb. bag of "Nilite" 101 or higher-density "Nilite" 202, you'll enter a new era in blasting.

Now at last you have two low-priced, free-running blasting agents that give you Du Pont quality performance, shot after shot.

You don't mix "Nilite" on the job. You don't mix it at all. Just rip open the bag and pour it into any hole—small, medium, large—from 2" diameter up. No clogging, no bridging in the hole.

No clouds of dust, and no ingredient to cause headaches. No messy oil-stained bags.

But easy loading is only part of the story of "Nilite." For full data on rock-breaking power, better propagation, greater safety and other advantages, send for our new fact sheet on "Nilite" or call your Du Pont distributor or representative. Start saving on your blasting . . . soon. Du Pont, Explosives Department, 6440 Nemours Building, Wilmington 98, Del.

Flows freely even in holes as small as . . .

DU PONT
REG. U.S. PAT. OFF.

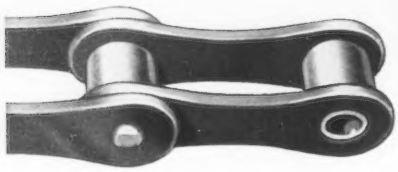
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

NILITE®

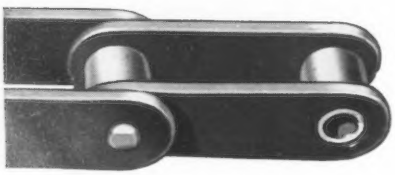
SINGLE STRAND

DOUBLE STRAND

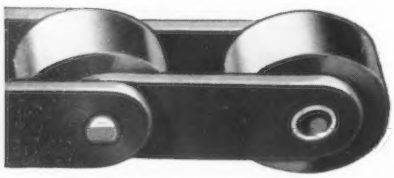
SINGLE STRAND, HEAVY SERIES



DOUBLE PITCH TRANSMISSION



DOUBLE PITCH CONVEYOR



DOUBLE PITCH CONVEYOR, LARGE ROLLERS

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look under "Dodge Transmissioneer" in the *white* pages of your telephone directory, or in the yellow pages under "Power Transmission Machinery."

TAPER-LOCK SPROCKETS DODGE ROLLER CHAIN

DODGE Quality Roller Chain, teamed with Dodge Taper-Lock Sprockets, results in chain drives and chain conveyors that have the precision, efficiency and stamina necessary for the real economy of *long life*.

Moreover, Taper-Lock's reusable bushing makes a difference in overall cost. The ease of Taper-Lock mounting, the elimination of reboring, keyseating, and wasted time, add to the saving. Precision machining and true articulation lengthen the life of *both* sprocket and chain.

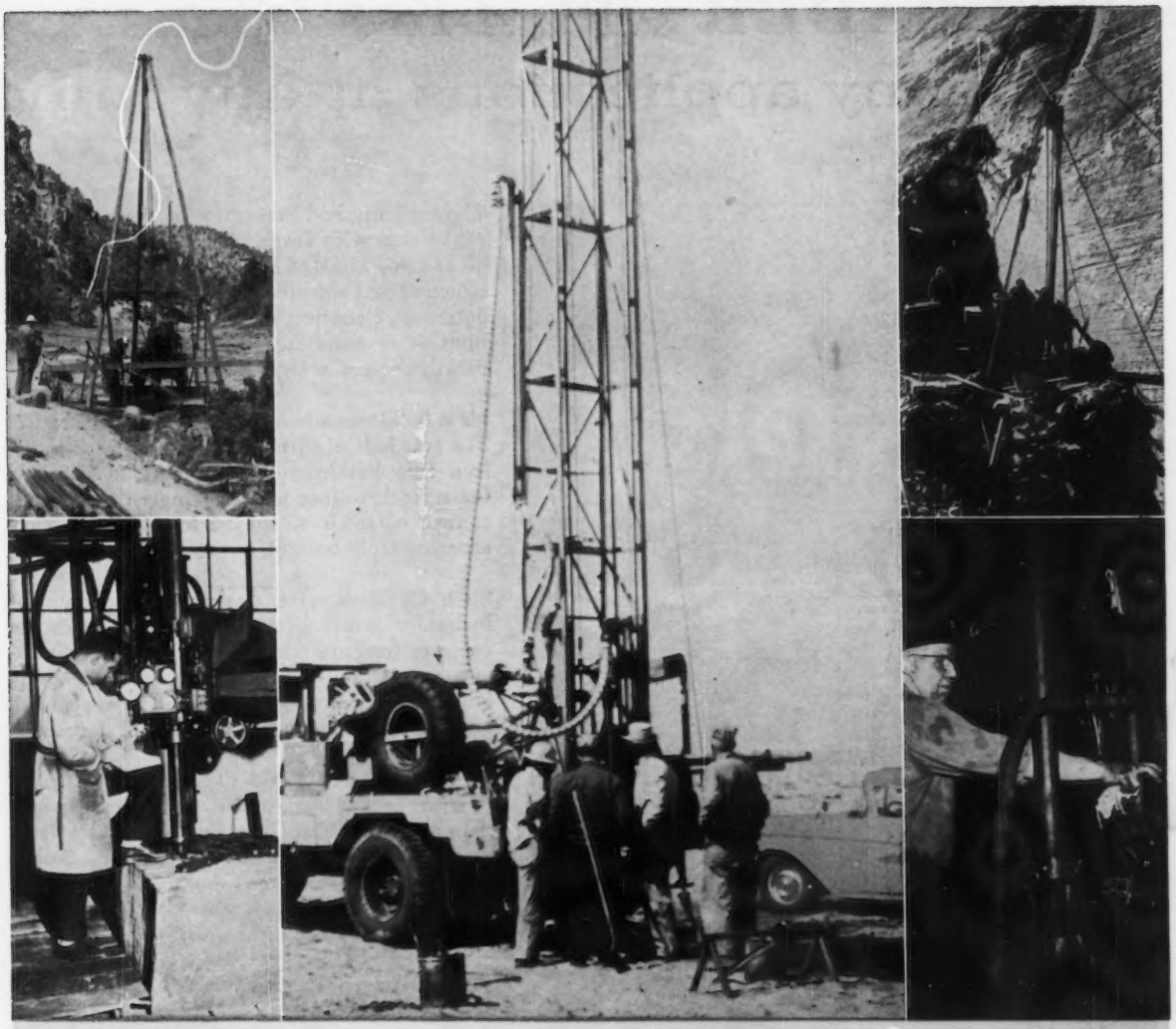
The Dodge line of chain, including standard attachments, is extensive. It meets a high percentage of all chain requirements.

In the Double Pitch series (both Transmission and Conveyor) the sizes which require special spacing for perfect tooth action are offered from stock in special double pitch design — to double the life of the chain and the sprocket!

Ask your local Dodge Distributor. Or write us for bulletin.

DODGE MANUFACTURING CORPORATION, 3100 Union St., Mishawaka, Ind.

DODGE
of Mishawaka, Ind.



Operate at "Less cost per foot" . . .

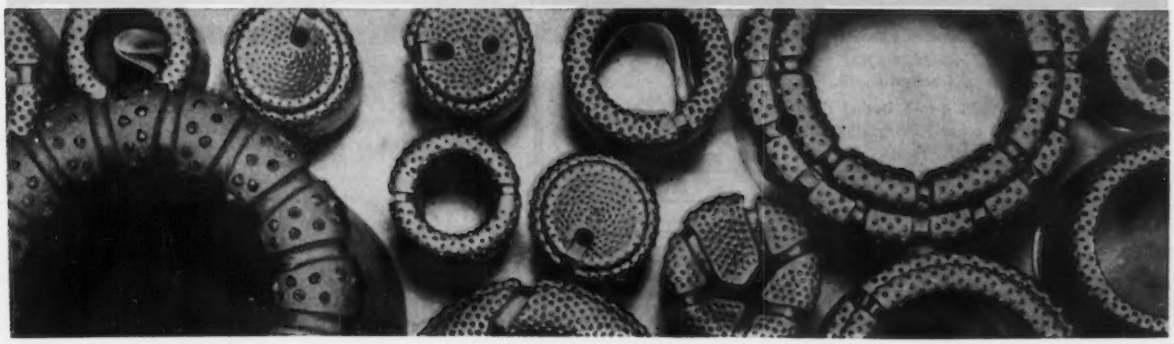
. . . with Christensen diamond bits and core barrels "engineered" for your particular drilling problem. Experienced field consultants are available regardless of your job location or scope of operations.

"Less cost per foot"

CHRISTENSEN DIAMOND PRODUCTS

MAIN OFFICE AND PLANT 1937 SOUTH 2nd WEST
SALT LAKE CITY, UTAH

SERVICE FROM WORLD-WIDE SALES OFFICES AND MANUFACTURING PLANTS



PAYLOADER with 4-in-1 Bucket has many applications at any mine

The mobility and versatility of the rubber-tired PAYLOADER with Drott "4-in-1" Bucket is paying off at many kinds of mines — on production, construction and maintenance work. Because it can do shovel, clamshell, scraper and bulldozer operations it is handling many different jobs that usually require several special machines.

It's a Bulldozer when the clam portion is raised. The rear half of this unique two-segment bucket is a true bulldozer with engineered curvature for smooth rolling action. Finger-tip hydraulic control of pitch of the blade makes for close, accurate depth control.

It's a Clamshell with positive and powerful hydraulic gripping action that surrounds and captures irregular objects and picks up piles of material without the need for tractor motion. Stumps, timbers, props and boulders are quickly gripped and loaded, or placed where desired.

It's a Scraper that works like a carpenter's plane — with the rear blade as the cutting edge and the clam portion slightly open and acting as a depth gauge. It can take shallow cuts of the desired depth with the material boiling up into the bucket. Like a carryall scraper, too, it can spread its loads to desired thicknesses.

It's a Shovel that can always be loaded and emptied like a conventional bucket. When additional dumping clearance and reach are desired, or when handling sticky materials, dumping the load by opening the clam, rather than by forward tilt of the bucket, is favored.

All five 4-wheel-drive PAYLOADER sizes are available with these exclusive-on-rubber "4-in-1" buckets in 1, 1⅛, 1¾, 2¼ and 4 cu. yd. capacities respectively. Your Hough Distributor is ready to discuss the profit-making potentials of any PAYLOADER tractor-shovel with the "4-in-1" or other Allied Equipment.

THE FRANK G. HOUGH CO.
726 Sunnyside Ave., Libertyville, Ill.

☐ Send PAYLOADER 4-in-1 bucket data
☐ Send data on other PAYLOADER Allied Equipment

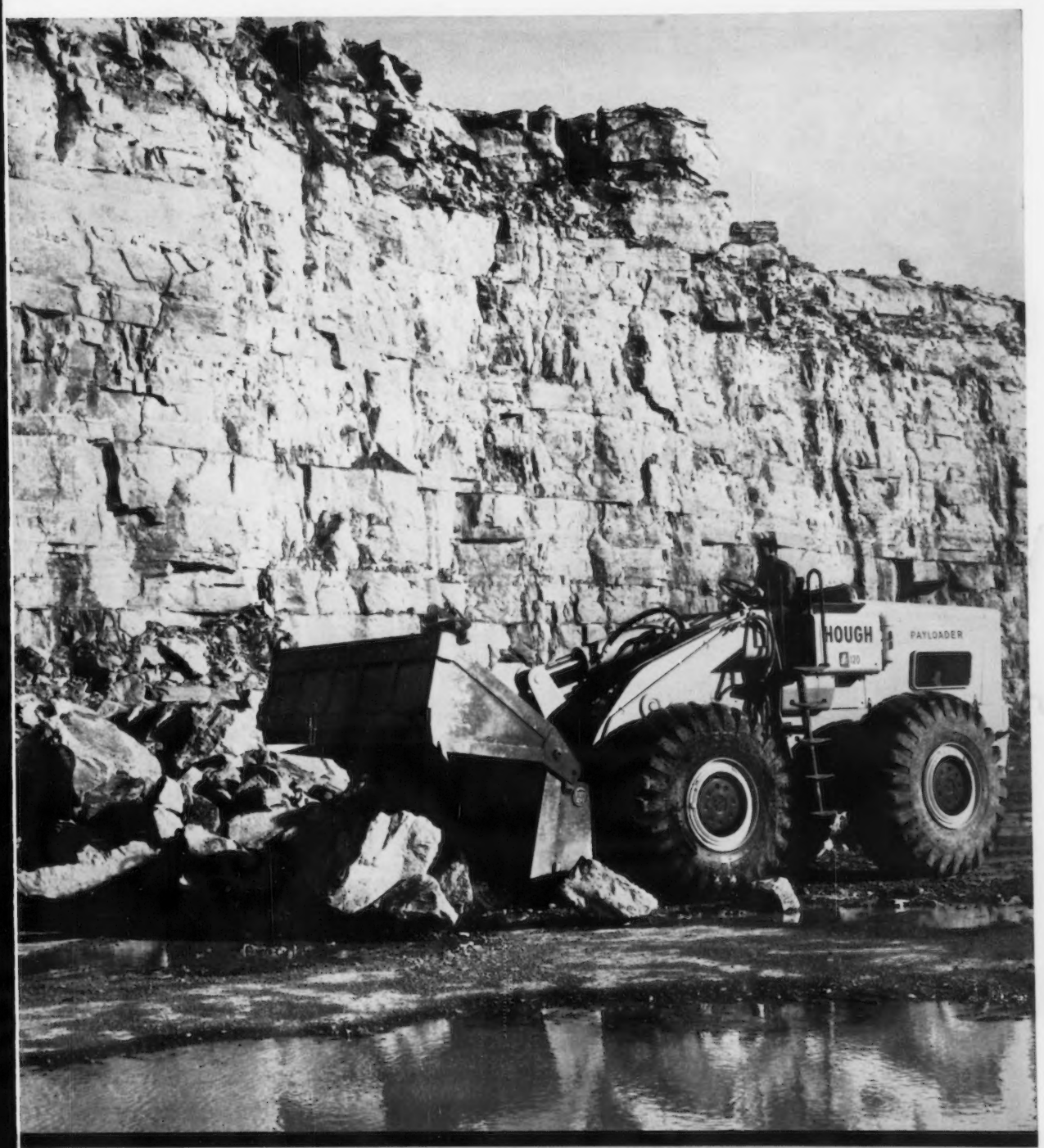
Name _____
Title _____
Company _____
Street _____
City _____ State _____

5-B-4

THE FRANK G. HOUGH CO.
LIBERTYVILLE, ILLINOIS
SUBSIDIARY - INTERNATIONAL HARVESTER COMPANY

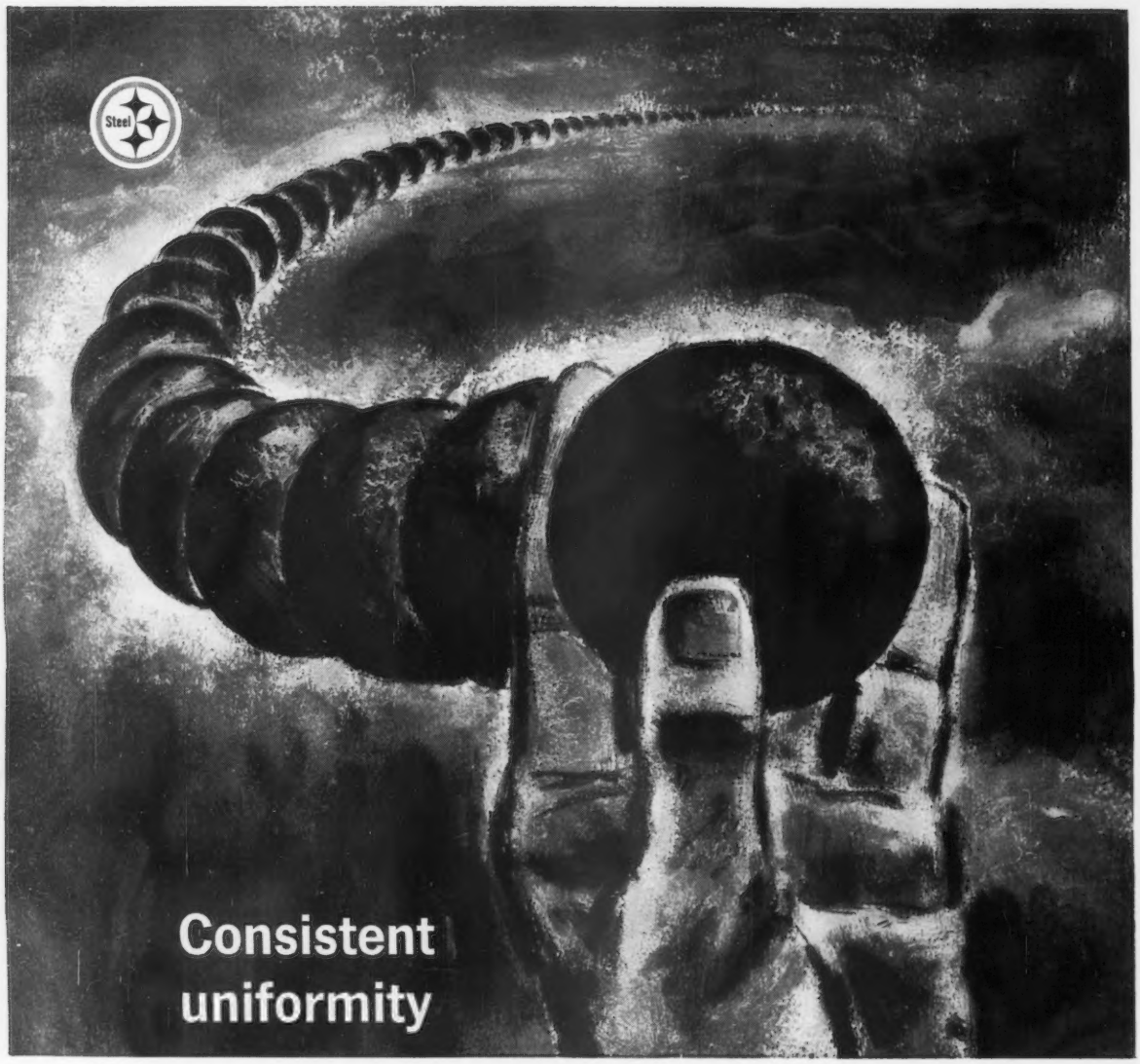
HOUGH®

HOUGH, PAYLOADER, PAYMOVER, PAYLOGGER, PAYLOMATIC and PAY are registered trademark names of The Frank G. Hough Co.



The 4-cu. yd. Drott 4-in-1 bucket and the boom arms of the big H-120 "PAYLOADER" are made of premium, triple-strength "T-1" steel. This eliminates over a ton of dead weight and increases payload capacity.

PAYLOADER®

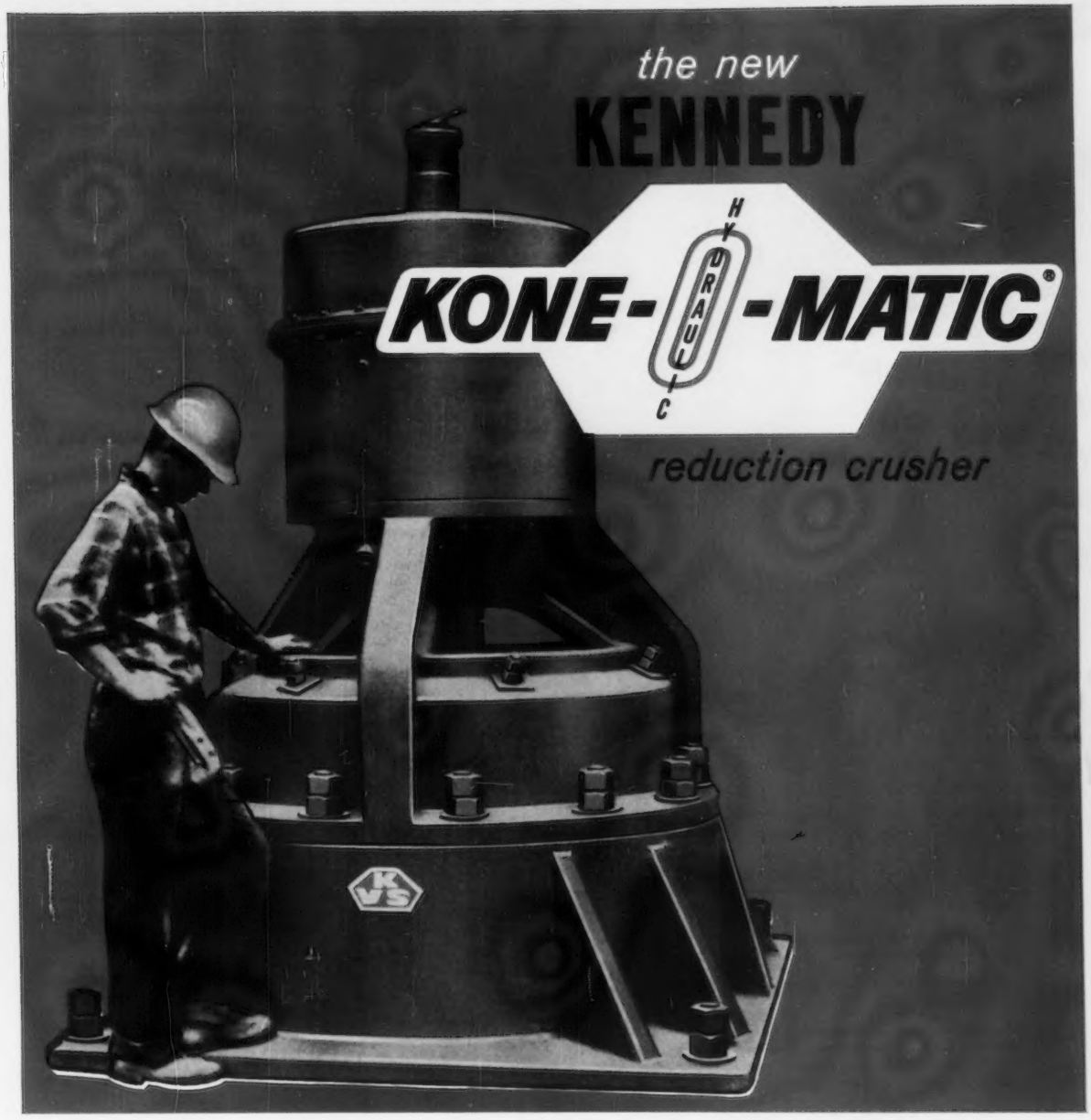


has earned customer acceptance

Consistent uniformity, right down to the core, is a big reason why more than a million tons of Sheffield Grinding Balls have been used in every kind of grinding job, around the world. They're uniformly hard, uniformly tough, with a uniformly dense grain structure throughout. That's why Moly-Cop Balls keep their sphericity longer, give a better grind at a lower cost per ton. It's the result of Sheffield's constant quality control in alloying, forging and heat-treating. **Sheffield Division, Armco Steel Corporation, Sheffield Station, Kansas City 25, Mo.**

SHEFFIELD
MOLY-COP
Grinding Balls

ARMCO Sheffield Division



- **With the *KONE-O-MATIC* Crusher, setting is sensed and held in position automatically by a multi-piston, fully hydraulic suspension system!**
- **Tramp iron is automatically released and *KONE-O-MATIC* is back to its setting *fast*, with no strain, shock, bump or damage!**
- **Setting can be changed instantaneously by finger-tip control without shutdown!**
- **And the new *KONE-O-MATIC's* feed opening is lower and larger, size for size, than any other crusher we know of!**

These, and many other exclusive features, add up to more productive hours per year, and therefore, more output; to fewer operating headaches; to a more evenly sized product; and best of all, you'll save on overall operating cost! This has been proven in actual quarry operations! We know you'll like the *KONE-O-MATIC!*

Send today for the new KENNEDY KONE-O-MATIC Bulletin, KOM-61.

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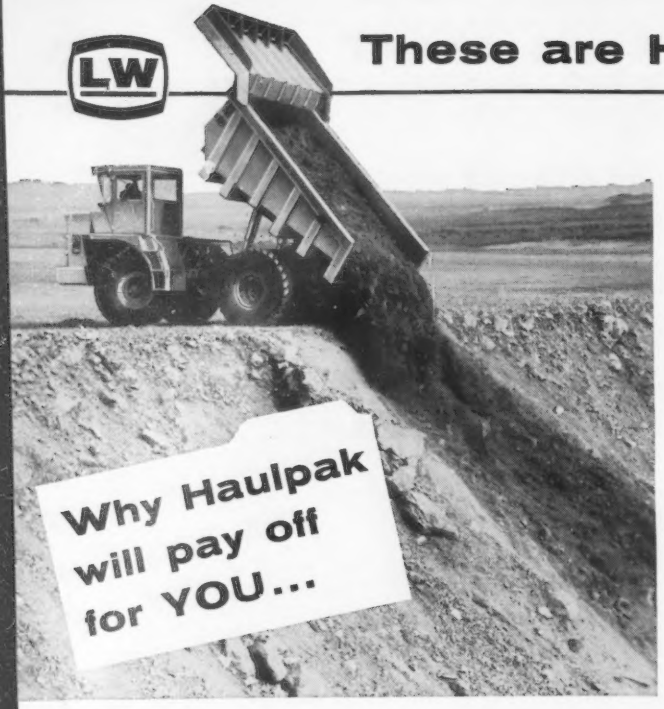
Primary & Secondary Gyratory Crushers • Jaw Crushers • Roll Crushers • Impact Breakers • Hammer Mills • Rod, Ball & Tube Mills • Rotary Kilns & Kiln Accessories • Dryers • Scrubbers • Screens • Pneumatic & Mechanical Conveyors • Complete Crushing, Lime, Cement & Carbon Paste Plants • Research & Testing Services.

These are HAULPAK® advantages



A highway truck cannot become an off-road hauler just by increasing its "iron", horsepower, or capacity. That's why LW engineers "threw out the book" when designing Haulpak. They started from the ground up to design a *new* concept in off-road haulers. The result is a bigger, tougher, faster, safer machine... with bigger returns on your hauler investment.

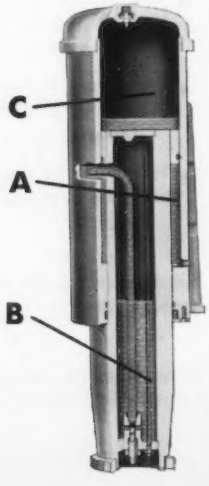
1. "Power-Miser" radiator fan*, needs less than 10 hp. (Conventional fans need up to 35 hp!) Automatically disengages when not needed.
2. Cab, engine, and radiator, are fully mounted on rubber to isolate engine vibrations.
3. 15° windshield tilt reduces glare, keeps dirt and moisture from accumulating.
4. Automobile-sized steering wheel turns Haulpak full left to full right in only 4⅛ revolutions. In either direction, inside wheel can be cut full 45°, for non-stop turning circle in diameter as small as 44'6".
5. 52"-wide cab for greater operator comfort and efficiency. Offset to left for full visibility. Five adjustable ventilators. "Buddy" seat for trainee or time-keeper.
6. Double-reduction rear-end of drive train, proved on LW earthmovers around the world. Only 6 big gears, not 12 little gears as in conventional drives. And over 50% stronger than conventional drive trains!
7. 15% less hp is needed to turn gear train than on conventional trucks. Double-reduction drive assembly also permits bolt-circle wheel mounting, for far less trouble.
8. Differential is famed LW power-transfer unit, unequalled for simplicity, trouble-free operation, and effectiveness.
9. All tires are same size and interchangeable.
10. Frame fabricated of special alloy, high-tensile-strength steel. Modified box section construction, continuous welded with integral front bumper, center members, and rear cross section ... for maximum strength.
11. Exhaust-heated body is standard. Keeps body dry for easy discharge of wet, sticky materials. Eliminates exhaust stack, and muffles operation of truck for greater operator efficiency, safety.
12. Power-assist steering is standard equipment. All steering components are located high and protected by frame.
13. High front ground clearance...6 to 10 inches more than other haulers.
14. Aircraft-type multiple-disc brakes... four times bigger than most haulers offer. *Three other brake systems,* including hydraulic retarder*.
15. Body is completely rubber-mounted. No wear bars or end plates needed.
16. High-pressure air storage in cross-frame, eliminates need for externally-mounted air storage tank.
17. Twin rams raise body to high angle in seconds! Inverted ram mounting avoids dirt falling into ram seals, permits shorter, simpler circuit.
18. Deep-well "V"-shape body carries up to 8 tons of material below floor line of conventional vehicles. Gives Haulpak lowest center of gravity, solid stability on turns and side-slope operations.
19. Fuel is stored in rear frame structure, with convenient center-fill. No need for big, clumsy tank, and not exposed to damage.
20. Straight, smooth body floor speeds ejection. No "kick up" at back, means unit stays steady, and on ground, when dumping.
21. Floor made of super-strength 100,000 PSI yield steel, as is every Haulpak surface in contact with the load!

*Applies to the four largest size Haulpaks.

Perhaps the BIGGEST "difference": Revolutionary Hydrair® Suspension

Most *unusual* feature of Haulpak is Hydrair suspension. Each front wheel is mounted to a piston, which operates inside a frame-mounted cylinder. Surrounding the piston is a circular chamber of oil, (A) connected by tube to an oil reservoir (B) inside the piston. As the wheel rolls along surface irregularities, the up and down motion of the piston forces oil in and out of the piston reservoir. This, in turn, compresses and decompresses nitrogen gas contained in the space (C) above the oil reservoir, snubbing the overall movement of the piston and wheel, thus absorbing shocks and leveling the ride.

In addition to these "spring action" benefits, Hydrair eliminates the need for a front axle and related mountings... providing substantially higher ground clearance... and permitting an exceptionally short turn-radius.



that lower your costs . . . boost your output

HP-2422-G-2

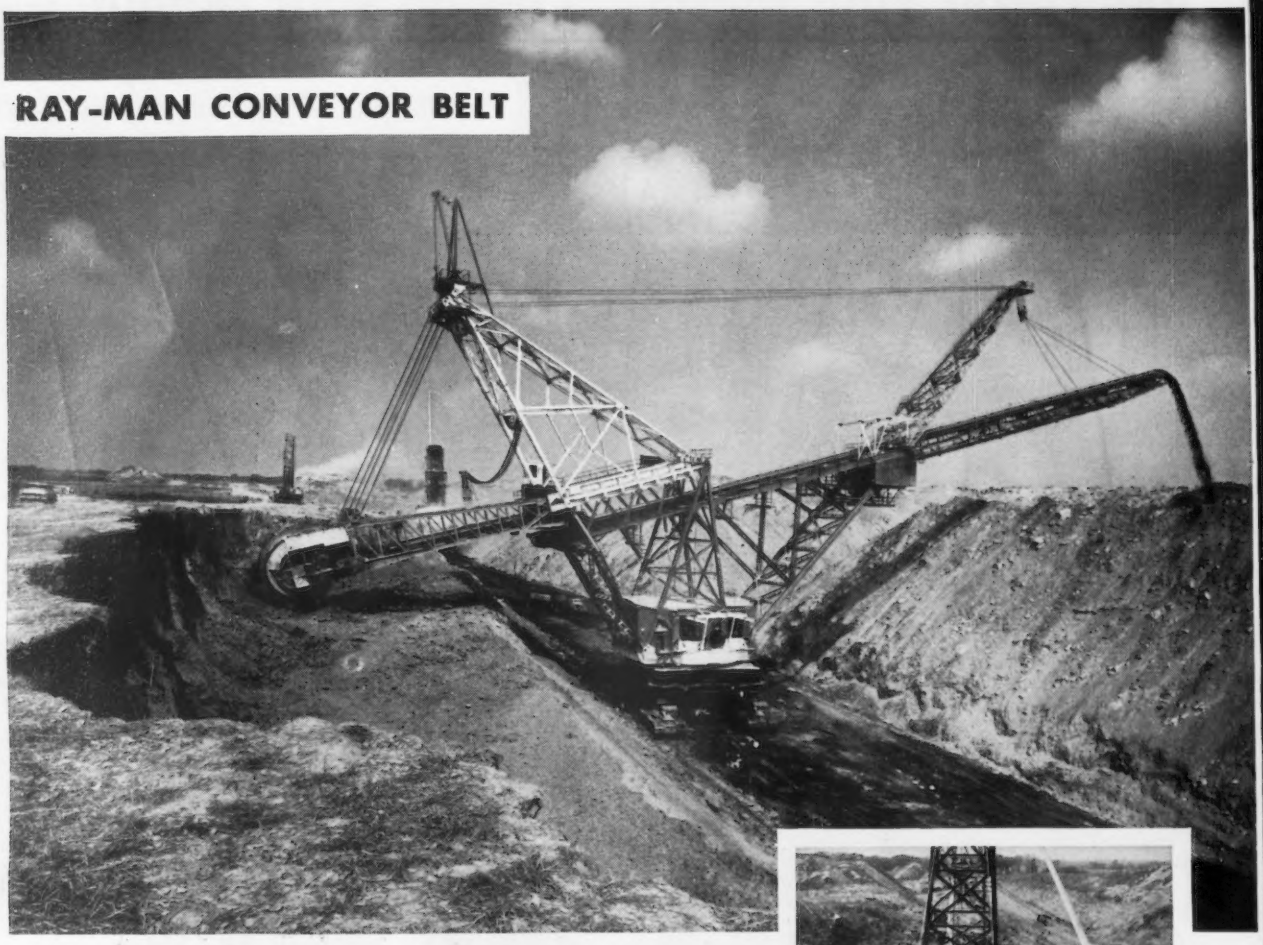
Choose HAULPAKS to match your production requirements

CAPACITY	60 Ton	42 Ton	32 Ton	27 Ton	22 Ton
HORSEPOWER	550	430	380	335	320
TOP SPEED (in MPH)	46.6	47.7	38.8	35.4	23.7
NET WEIGHT (in Lbs)	66,000	52,950	46,030	43,900	42,800

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit



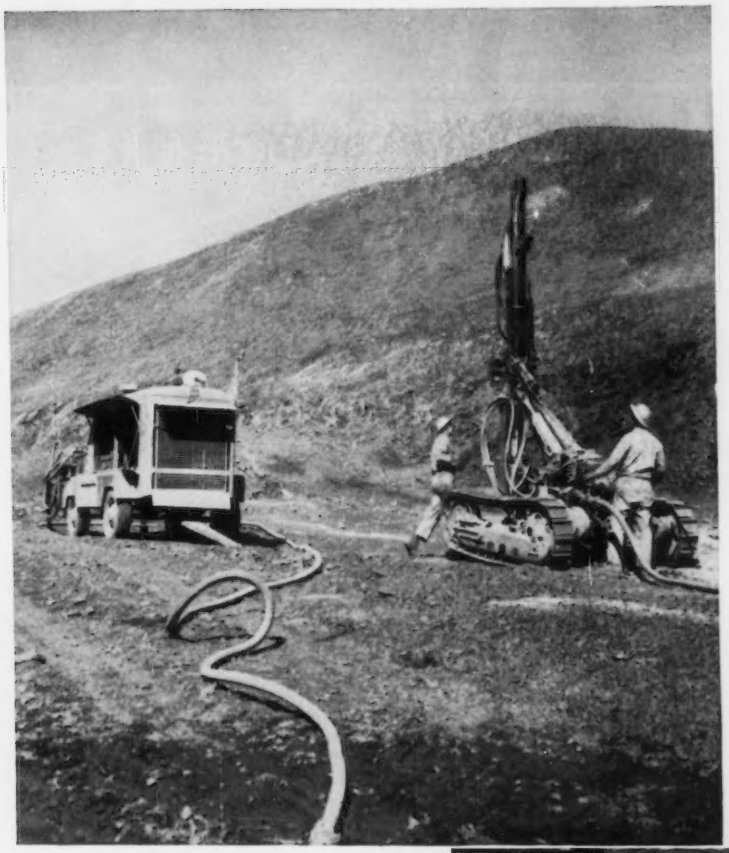
RAY-MAN CONVEYOR BELTS
On Giant Wheel Excavators
Move Overburden More Than 400 Feet ...At 5100 Tons Per Hour!

High-speed belt conveyors, with huge carrying capacities, are an integral part of this new 1,600 ton wheel excavator built for Peabody Coal Company at Bucyrus-Erie Company. High conveyor speeds—over 1,000 FPM—and high impact, put a tremendous strain on belt and belt splice. Ordinary belts can't take it. Ray-Man Conveyor Belting met the production standards of Peabody's giant earthmover—to handle *full* loads of overburden at *full* speeds *without* costly downtime for splice repairs!

Ray-Man belts on other machines of this type have hauled over 12,000,000 tons—outperforming all competitive belts. Splices last twice as long because double ply compensation relieves outer ply stress at bends. Ray-Man trains naturally, resists impact and ripping, requires no breaker ply. Exclusive XDC cover prolongs belt life. Let an R/M distributor show you how an R/M Conveyor Belt can outperform other belts on *your* conveyors. Write for Bulletin M302 and Catalog 25CB.

OVER 900 FT. OF 54" RAY-MAN CONVEYOR BELT are required for digging ladder and stacker conveyors on this huge Bucyrus-Erie Wheel Excavator. Machine will help increase output a million tons annually at Peabody Coal Company's River King Mine near Freeburg, Illinois.

RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION • PASSAIC, N. J.
ENGINEERED RUBBER PRODUCTS



HOMOFLEX HOSE Weighs Less Than Any Other Hose For Equal Pressure

It's flexible as a rope, too . . . the easiest handling air hose you can use. Homoflex has no pre-set twist . . . coils and uncoils in *any* direction *without* kinking. Strength member and tube are virtually inseparable. Uniform inside and outside diameters make it easier, *safer* to couple.

- **Super-Strong** — assures longer, trouble-free service life
- **Precision Built** — with super-strength, low-stretch cords
- **Mandrel-Made**—no pre-set twist
- **Kinkless**—coils and uncoils freely in any direction
- **Homogeneous Construction**—provides inseparable tube-to-cover bond
- **Safer, Easier To Couple**—inside and outside diameters are uniform

Ask about rugged Homoflex and other types of R/M hose for your applications. Write for Bulletins M620 and M694.

CONDOR Flexible Rubber Pipe Outlasts Iron or Steel 3 to 10 Times

It's engineered for mine service . . . for handling tailings, cinders, slag or flotation feed . . . on dewatering lines—wherever pipelines are subject to corrosion, abrasion, vibration or water hammer. Types to withstand pressures up to 250 psi feature new Hydro-Lok built-on flanges for positive seal.

R/M Rubber Expansion Joints—overcome pipe expansion stress and avoid misalignment, offer maximum resistance to shock, require no gaskets. Write for Bulletin 7152.

This Condor Rubber Pipe is still in service after 9 years. Previously steel pipe had to be replaced every year.

RM113

JOE IS PROUD OF HIS

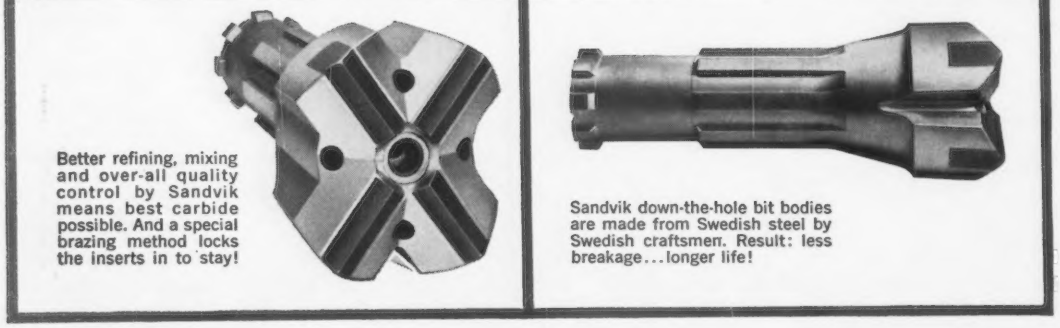
Good reason, too! He's got a 9-inch down-the-hole bit from Sandvik-Coromant, and that means he's got a bit that's better than he's ever used before!

Strong statement? Sure. But here's proof:

First, Sandvik is one of the world's largest and most experienced manufacturers of tungsten carbide. Therefore, Joe gets the highest quality carbide possible. From more effective refining, through better mixing, to more careful control of grain size—everything possible is done to assure Joe longer bit life and more feet between sharpenings.

More proof: Sandvik carbide inserts *stay in*, thanks to our unique brazing method. And since the entire bit is made from Swedish steel—Joe knows breakage won't be a problem.

You'll be happy with Sandvik-Coromant down-the-hole bits, too. They're available from 4¾ to 9 inches in diameter, and for all types of rigs. Get in touch with your nearest Atlas Copco office today, or write to Dept. EMJ-61-1.



Better refining, mixing and over-all quality control by Sandvik means best carbide possible. And a special brazing method locks the inserts in to stay!

Sandvik down-the-hole bit bodies are made from Swedish steel by Swedish craftsmen. Result: less breakage...longer life!

Atlas Copco Inc.

610 Industrial Avenue, Paramus, New Jersey • COlfax 1-6800
930 Brittan Avenue, San Carlos, California • LYtell 1-0375

NEW BABY!

This is automatic operation

NO HAND ON THE THROTTLE!

GRS ATO—Automatic Train Operation—is ideal wherever operations are repetitive, such as in hauling ore, coal, or gravel.

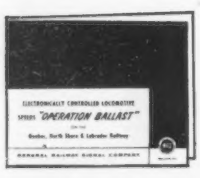
The system operates without a train crew and may be applied to diesel-electric, electric, or any standard locomotive. It can include automatic spotting and automatic dumping, in addition to starting, running at desired speeds, and stopping.

GRS ATO may be arranged to operate by remote control, by programing, or combinations of both. The system is fail-safe. For utmost flexibility, manual override of the automatic operation is provided.

ATO
AUTOMATIC TRAIN OPERATION

GENERAL RAILWAY SIGNAL CO.

ROCHESTER 2, NEW YORK NEW YORK 17, N. Y. • CHICAGO 1, ILL. • ST. LOUIS 1, MO.

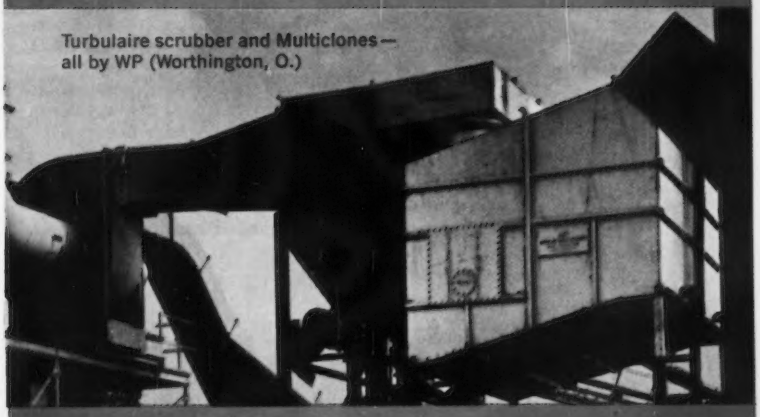


For the full story of a GRS ATO installation now in operation ask for Bulletin 197. Write Advertising Department, Section E.

3120

Multiclone "9VGR" by WP collects alumina dust from processing kiln (Calcutta)

An aluminum producer in India... and an Ohio rock crusher... agree:



Turbulaire scrubber and Multiclones—all by WP (Worthington, O.)

When DUST is your problem— CLEAR IT WITH WP*

For an efficient, economical solution to any dust control problem—look to Western Precipitation. WP is uniquely fitted to handle your unique problem—being the one organization that custom designs, engineers and installs ALL types of dust and fume control equipment: Precipitator, Mechanical, Jet-Cleaned Filter, Hi-Temp Filter, scrubbers and engineered combinations.

With no axes to grind for any one system, WP engineers will give your job a completely unbiased recommendation—whether it's a quote on your specifications, a single component, or a completely engineered installation... small, major, simple, or complex.

An inquiry—on your business letterhead—will bring you literature promptly. Just write Western Precipitation, 1000 W. 9th St., Los Angeles 54, Calif. (In Canada, write 8285 Mountain Sights Ave., Montreal, P.Q.)

Dust and fume control since 1907

*WESTERN PRECIPITATION

Los Angeles 54 • New York 7 • Chicago 2 • Pittsburgh 22 • Atlanta 5 • San Francisco 4

Division of Joy Manufacturing Company

ELECTROSTATIC Precipitators
MULTICLONE Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
THERM-O-FLEX HI Temp Filters
TURBULAIRE Scrubbers
JOY-MICRODYNE Scrubbers
also: **HOLO-FLITE** Processors
HI-TURBIANT Heaters
TURBULEX Calciners

STOP . . . and consider the important cost, safety and speed advantages of **NATIONAL** vertical load suspension devices.

National offers a family of specially engineered load suspension devices that are now being used successfully in new car designs ① narrow gage cars ② narrow body cars ③ and granby cars ④ These designs are fully proven, fully adaptable for use in new rolling stock or for use in equipment upgrading programs. Correct vertical load suspension extends equipment life, minimizes spillage, provides greater personnel safety, and speeds your operations.

A-3924A

Mine Sales • Transportation Products Division

International Division
Cleveland 6, Ohio

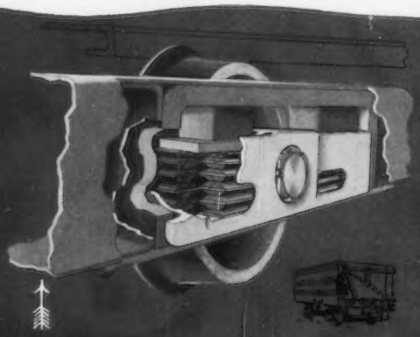
National Malleable and
Steel Castings Company of Canada, Ltd.
66 Portland St., Toronto 2B, Ontario

NATIONAL
MALLEABLE AND STEEL
CASTINGS COMPANY
Cleveland 6, Ohio

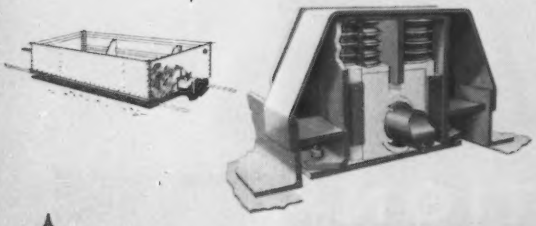
DESIGN WITH STEEL CASTINGS — STRENGTH IN STEEL — Centennial 1861 1961

NC-1 MINE CAR TRUCKS • RUBBER CUSHIONING DEVICES • NACO STEEL WHEELS
NACO STEEL LINKS & SWIVEL HITCHINGS • WILLISON AUTOMATIC COUPLERS

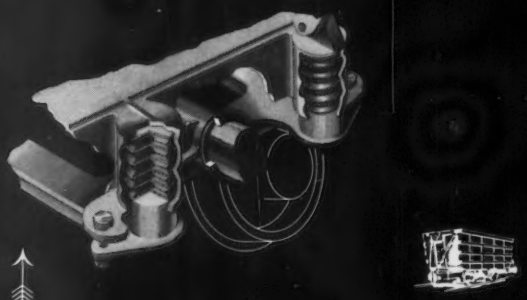
① National MI-245 rubber units, for 4-wheel rotary dump car, minimize vertical oscillation of cars through high absorption characteristics.



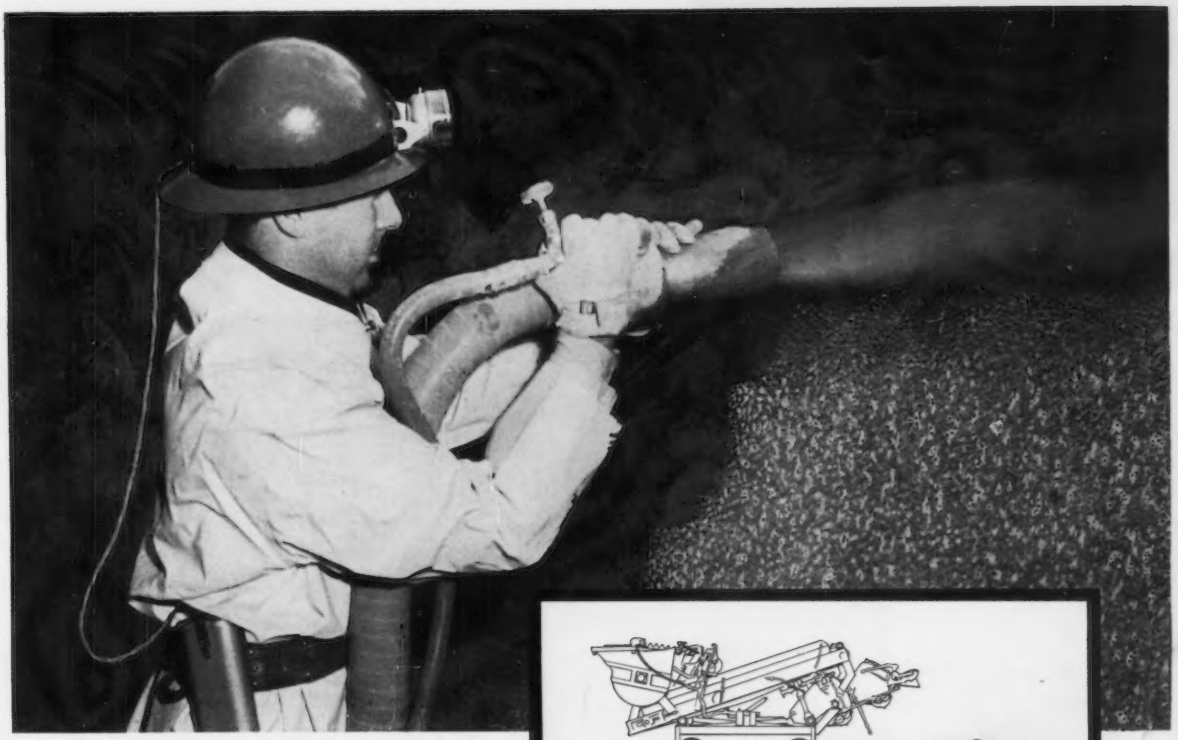
② Twin National MI-235 units used on each side of the axle center line and outboard of the wheels.



③ Twin National MI-240 units used on each side and over the axle inboard of the wheels.



④ Twin National MI-240 units, used in narrow body cars, are located in line with wheels to eliminate side overhang.

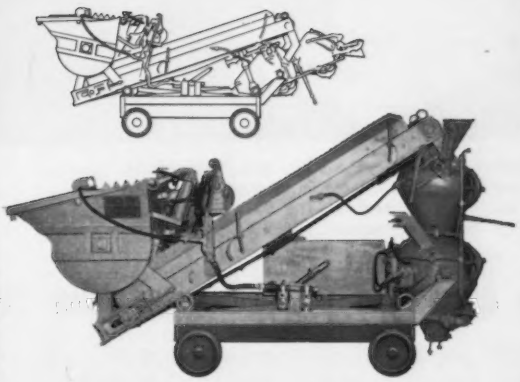


RIDLEY MODEL C-3UG
COMPACT, FULLY INTEGRATED
CONCRETE GUNNING RIG

places concrete at low cost anywhere in mine or tunnel

C-3UG goes everywhere underground ... lines and reinforces at rates up to 12 tons per hour!

Ridley's new concept of low cost reinforcement in mines and tunnels allows application of concrete with minimum interruption. C-3UG collapses (or disassembles if necessary) for passage through restricted drifts. It guns up to 12 tons per hour continuously, and easily seals off even appreciable flows of ground water. Your men can operate it at a cost far below that of timbering, lagging, bolting, or pouring concrete... and do a *better* job!



SPECIFICATIONS: Only 5'6" high in shooting position, 4'2" collapsed; 3'6" wide . . . mounts on mine car, skids, or pneumatic-tired trailer . . . powered by mine air line or compressor . . . reduces rebound loss and cleanup by 50% . . . simple design needs little maintenance. It's a profitmaker any way you look at it! **Mail coupon today.**

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☐ Send me name of nearest Ridley representative.
☐ Rush complete data on Ridley C-3UG

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COMPANY_____

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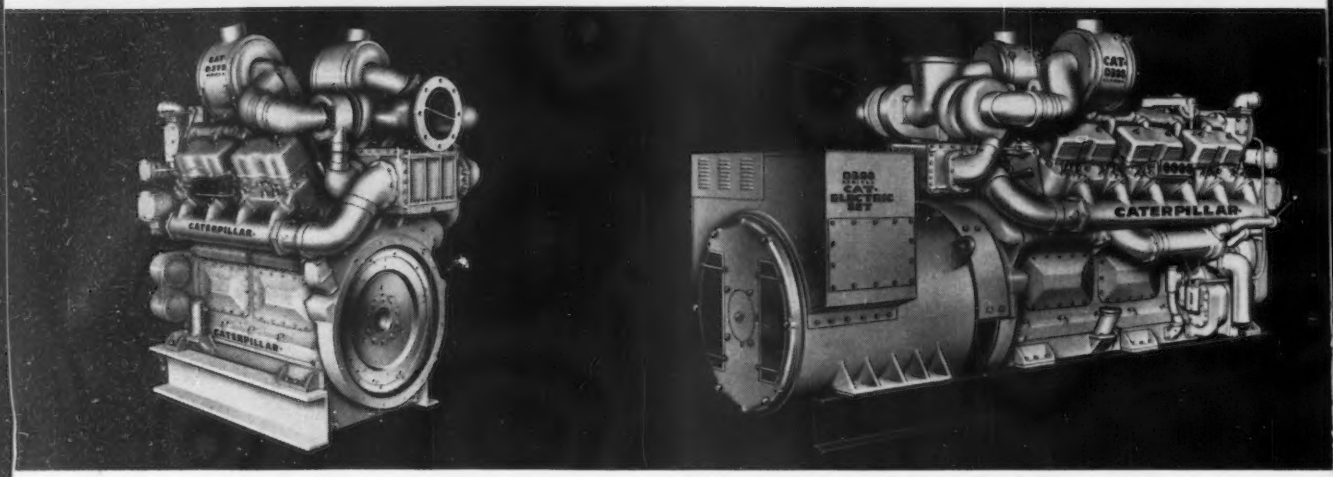
engine power BY CATERPILLAR

new Cat D398-D379



Cat D379 Industrial Engine. The 6.25" bore, 8.00" stroke D379 and D398 both offer the latest in attachments including marine gears and generators. The D379 Electric Set develops up to 350 KW continuous, 400 KW standby.

Cat D398 Electric Set. The D398 Electric Set shown here with Static-Regulated, Static-Excited Generator features a new generator with built-in static excitation system with no exciter generator or vibrating parts. Develops 500 KW continuous, 600 KW standby.

Give more horsepower per pound, per dollar than any other industrial engine in their class

The V12 D398 and the V8 D379 are rated at 950 and 630 maximum HP, respectively. Electric set versions reach to 600 and 400 KW. Marine ratings exceed 1000 HP. These engines are now available at prices that are less than crankshaft replacement prices of some competitive engines in their class.

Published list prices show the D398 to be thousands of dollars less than the next lowest priced industrial engine that will develop comparable horsepower. Other advantages are quality aluminum alloy bearings, aluminum pistons with cast-iron ring band for top two compression rings, drop forged-dynamically balanced crankshaft and high strength rigid block. These engines save in space and weight, too . . . with at least 35-40% less size and 4800 pounds less weight than other makes with comparable horsepower.

Here are more reasons why Cat D398 and D379 Diesels and Electric Sets give you extra value

NEW PERFORMANCE STANDARDS

- Turbocharged-Aftercooled design
- Static-Regulated, Static-Excited Cat Generators
- High flow lube and water systems
- Ability to burn wide range of fuels

NEW ENGINE FLEXIBILITY

- 100% HP from either end of engines
- Six available accessory drives – up to 50 HP each
- Controls available for either side
- Standard (counterclockwise) rotation or opposite rotation

NEW SERVICE EASE

- Fuel or lube filters serviced from either side
- Remove heads without disturbing manifolding
- Easily inspect or remove pistons, rods and bearings through large side ports
- Externally mounted oil pumps for easy inspection and maintenance

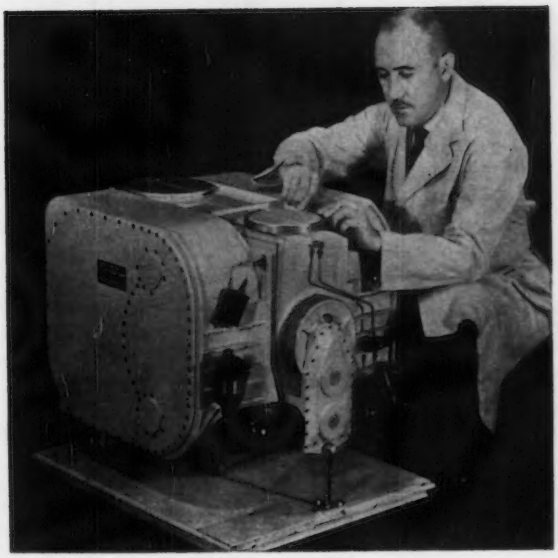
For complete specifications on the D398 and D379 Diesel Engines or Electric Sets, contact your Caterpillar Dealer or Caterpillar Engine Division, Peoria, Illinois.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

Caterpillar Tractor Co., Engine Division, Peoria, Illinois, U. S. A.

NEW PRODUCTS DIGEST

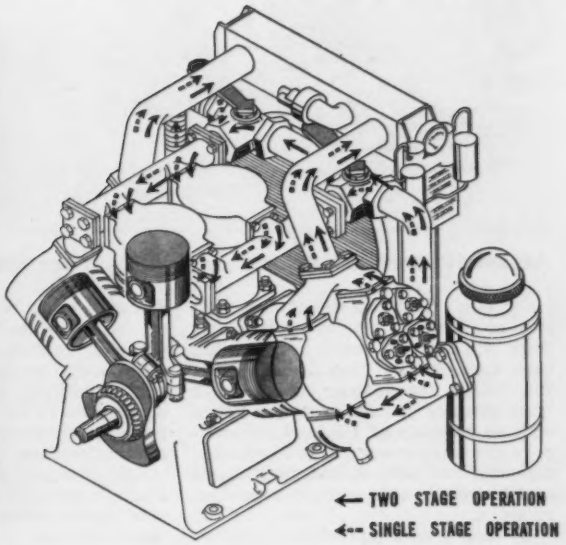


Economical 600-hp Gas Turbine (48)

SOLAR AIRCRAFT CO., International Harvester Co. subsidiary, has received a contract from the U.S. Navy Bureau of Ships for the development of a 600-hp gas turbine engine which it feels will surpass piston engines in competitive applications. It will contain principles and designs to make it a real contender for a number of applications formerly restricted to conventional reciprocating engines.

Solar said that a few of the engine's target characteristics include: 1) a life cycle to or better than conventional reciprocating engines—with considerably less maintenance; 2) fuel consumption of .4 lb/hp-hr, equal to reciprocating engines and well below current industrial gas turbine performance; 3) a cost competitive with conventional reciprocating engines.

The new engine, Solar claims, is a completely axial flow regenerative machine with a six-stage compressor, dual rotary regenerators, a single-stage gas producer turbine and a single-stage power turbine. It will operate at a compressor ratio of 3.8 and have a rotative speed of 21,500 rpm. Solar feels that the turbine will be used for vehicle and marine transportation, generators, pumps and compressor drives.



Compressor for One- or Two-Stage Operation (20)

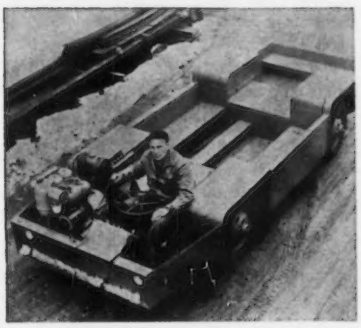
NEW TYPE STATIONARY COMPRESSER in three or six cylinder models to deliver 50 or 125 psi air at displacements from 260 to 1080 cfm has been developed by Le Roi Div., Westinghouse Air Brake Co. Although similar in design to the conventional two-stage compressor, extra valves and manifolding have been inserted to permit single or two-stage operation within the same machine.

When in single-stage operation, low pressure-high volume air is compressed through one stage in both low and high pressure heads without entering the second stage of the compression cycle.

By positioning the three-way valve on the suction side of the high pressure head to prevent atmospheric air from reaching high pressure heads without going through the compression first stage, Le Roi's unit is converted to two-stage operation.

Here's how to change from single to two-stage operation and vice-versa: (1) stop the compressor; (2) blow down the receiver; (3) change the setting on each three-way valve.

Horsepower requirements vary from 45 to 85 in the three-cylinder unit and from 105 to 175 in the six-cylinder model.



Personnel Carrier (42)

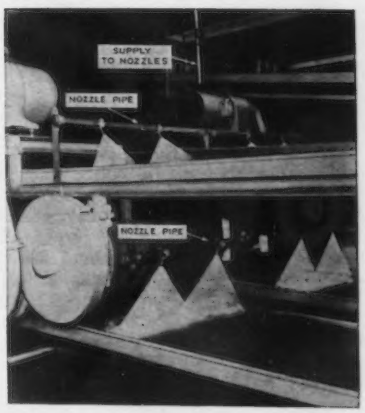
IMPROVED PERSONNEL CARRIER that can go 20 mph with a 5,000-lb capacity is now being marketed by a Getman Brothers.

The new unit, which can also be used as a utility truck, is 45-in. high, 77-in. wide and 17.8-ft long.

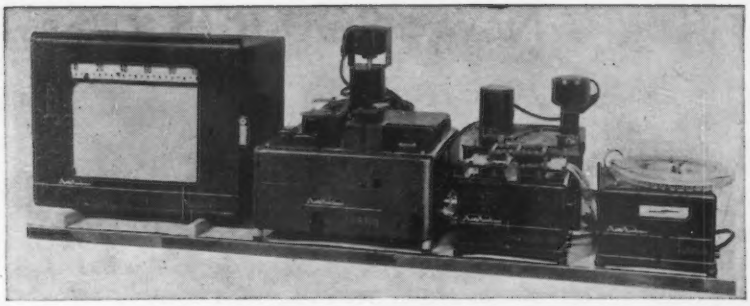
Automatic Belt Cleaner (10)

AN AUTOMATIC belt cleaning system which can be operated by one man has recently been introduced by the Sellers Injector Corp. With this system, the company claimed, a 200-ft conveyor belt, operating at an average speed of 20 fpm, can be cleaned in 10 minutes.

The two major components of the system are: 1) multiple high-pressure nozzles, spaced at intervals across the belt width, that are permanently positioned over and under the conveyor and which force powerful jets of hot water and detergent against the belt surface at pressures of 125-150 psi; 2) Sellers hydraulic jet unit (4,000 gph) which supplies the nozzles to give high cleaning impact and which is able to combine plant steam, cold water and detergent to deliver hot liquid at a discharge pressure two to 20 times higher than input steam pressure.



The new system is not limited to flat rubber belts—it may also be used to clean steel mesh belts, metal elevators and elevator belts.



Automatic Analyzer Accurately gets Parts per Billion (25)

NEW UNIT that automatically does all steps of a chemical analysis and integrates them into a continuous flow system has been developed by Technicon Controls, Inc. Called AutoAnalyzer, it can detect trace elements down to parts per billion with an accuracy of 1%, and automatically measures, mixes, purifies, processes, compares and records, and runs 20, 40 or 60 complete tests without human supervision.

By feeding an untreated sample to one flow cell, and the sample to be analyzed to another, the dual colorimeter provides a reading which is the true equivalent of the treated minus the untreated sample. Operated as two individual dual-beam colorimeters in the same housing, the unit permits each channel to operate independently of the other. Each measures the output ratio of sample vs. reference recorded in terms of optical density.

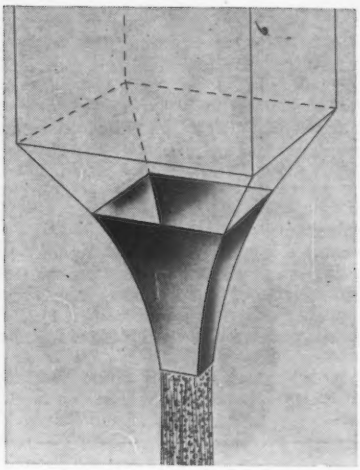
Technicon said that AutoAnalyzers are available for single or multiple component determinations, for laboratory or plant use—can handle cyanides, silica, phosphates, iron, chloride, aluminum sulphates, copper, etc.

Cement Tamping Plug (2)

THE TIME AND EXPENSE of preparing tamping bags for large dia horizontal blast holes is now being saved by Austin Powder Co.'s new two-piece cast cement plug.

The plug, called Austin ATP, consists of a cone and base which are loaded as a unit into the hole behind the explosive. To obtain maximum confinement, the solid cone is tamped into the base unit and seated securely in the blast hole. Austin claims that no additional stemming is necessary.

ATP is much easier to tamp and, because one plug eliminates the need for a number of bags, it proportionally reduces tamping time. It is available in sizes to fit holes with diameters from four to 10 in.



Improved Bin Outlet (5)

FULL AND UNIFORM flow of granular and lump bulk materials from bins, hoppers and silos has now been made possible by a new device developed by the Bin-Dicator Co.

According to the company, the efficiency of the device (called the Hyperbolic Outlet) is achieved through proper application of its patented design which reduces the restrictions to flow and increases the force responsible for flow through the outlet.

Bin-Dicator said that the Hyperbolic was not an attachment; that it replaces the lower section of a conventional hopper and becomes an integral part of the bin. It needs no maintenance, and eliminates the need for vibrators and other attachments presently used to increase flow of bulk materials from storage bins.

Transistorized Magnetometer (3)

THE JALANDER, self-contained transistorized flux-gate magnetometer can greatly reduce magnetic exploration field costs, according to Exploration Methods Inc. The unit is reliable, rugged, and exceedingly fast—average of only 10 sec needed to take a reading in the field. The number of stations which a man can occupy in a day is mainly limited by the physical ability of the

man to cover the project area. Exploration said that the availability of recording gear makes JALANDER doubly useful since it will produce a continuous magnetic profile record at a cost within reach of the smallest operators.

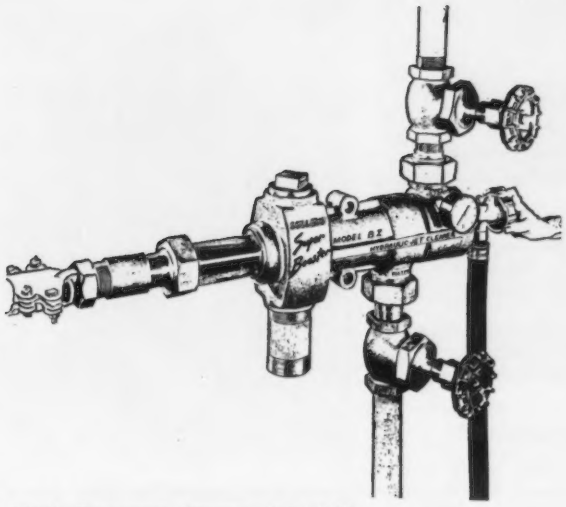
While being used, it is easily held —specific azimuth orientation is not necessary—and its range is plus or minus 250,000 gammas. JALANDER measures 3x12 in. and weighs only three lb.

Resistant Refractories (39)

TWO BRANDS of specialized silica refractories with high spalling resistance have just been introduced by Harbison-Walker Refractories Co.

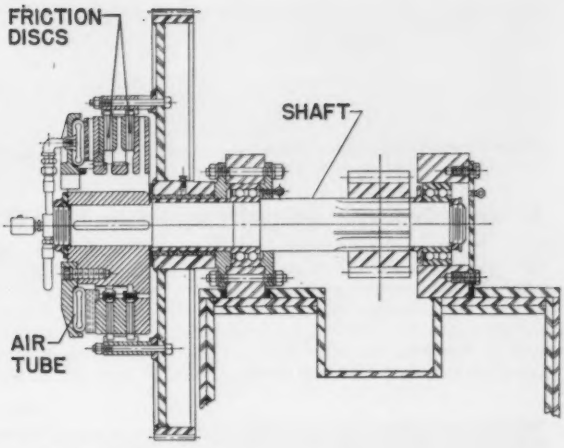
H-W said laboratory tests of three silica brands indicate that temperatures which break up conventional silica brick do not cause cracking or spalling in the two specialized silica brands.

The two brands, called Vega HP and Star Dash, have undergone a series of intensive tests. At one open hearth, Vega HP increased average roof life from 100 to 250 heats. In a steel foundry with average electric furnace roof life of 75 to 100 heats, Star Dash was used and lasted 152 heats.



High Pressure Steam Jet (19)

THE MODEL "BZ" Super Booster Jet Cleaner, produced by Sellers Injector Corp., Philadelphia, Pa., is designed for use either as a pressure pump for feeding large-capacity tank cleaning heads or as a continuous hot water generator. The hot liquid jet has a stream velocity of two miles per minute, and its temperature may be manually controlled between 115°F and 210°F. Using plant steam and water, the Jet Cleaner doubles the input steam pressure and gives an output of from 2000 to 10,000 gal per hr. Chemicals or detergents may be introduced into the jet stream by turning a manual-control valve. Detergents can be used up to 10% the volume of the jet stream.



Air Slip Clutch (12)

AN AIR-OPERATED slip friction clutch has been developed by the Marion Power and Shovel Co. for the crowd mechanisms of its 4161, 151-M and 191-M shovels. The air clutch already is standard equipment on the company shovels with dipper capacities of from 6 to 11-cu yd and Marion said that conversion kits are available for changing the mechanical slip friction clutch on the 4161, 151-M and 191-M models.

According to Marion, when the clutch is properly adjusted, it transmits the stall torque of the crowd motor without stalling. With the dipper at rest against the bank, the full power of the crowd motor can be applied with no clutch slippage. If the dipper should strike an extremely large rock or other obstacle while crowding into the bank with full power, the clutch will slip to protect the dipper and handle.

Rotary Drill Rigs (46)

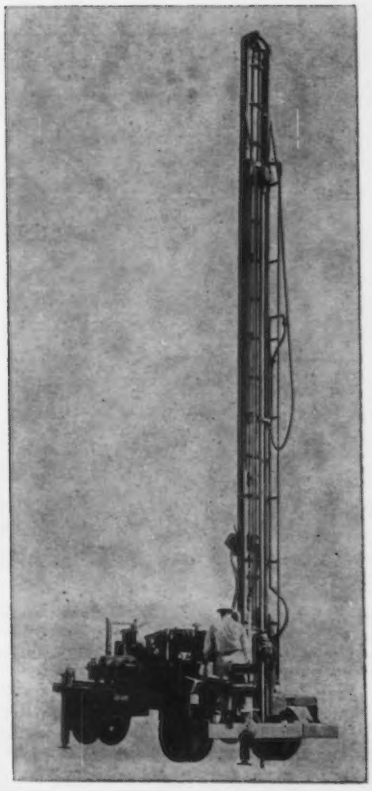
NEW LINE of mechanical drive rotary drills for 3-to 4½-and 6-to 7⅞-in. bit sizes and which are either truck, crawler or wheel mounted for rotary of down-the-hole drilling are now being marketed by Westinghouse Air Brake Co.'s Le Roi Div.

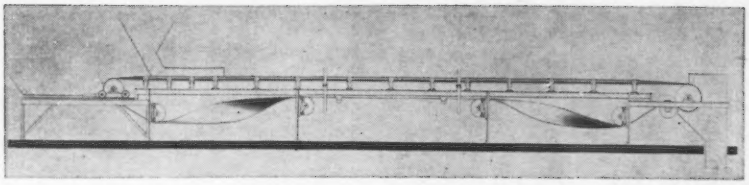
One of the new models, the LRD-3 (above), maintains steady drilling action and constant rpm on the bit at low machine speed through a series of gear reductions in the drive shaft which build up a high torque.

The other model, the LRD-2 (below) is a one-man rig and drills a 3- to 4½-in. hole with rotary or down-the-hole tools to a depth of 25 ft without changing pipe. For down-the-hole, the rotary table can be raised 16 in.—saving drilling time in hard rock and permitting down-the-hole tools to be inserted without drilling a preliminary hole with rotary bit. LRD-2 comes with either a gasoline or diesel power unit. The engine on the crawler is mounted on the frame and directs power through the sub-drive case to the compressor and rotary table. Sliding gear type clutch in the divider case transfers power from the transmission to the rotary table or propelling axle. Five-speed transmission is geared for rotary speeds between 40 and 250 rpm.

The LRD transmits power from the engine through the sub-drive case and transmission to the drive shaft. An 18 to 1 reduction ratio with the transmission in low gear is translated to the kelly with a 7 to 1 reduction through a right angle drive case.

The driller can adjust to the formation being drilled with a choice of 10 forward and two reverse gears.

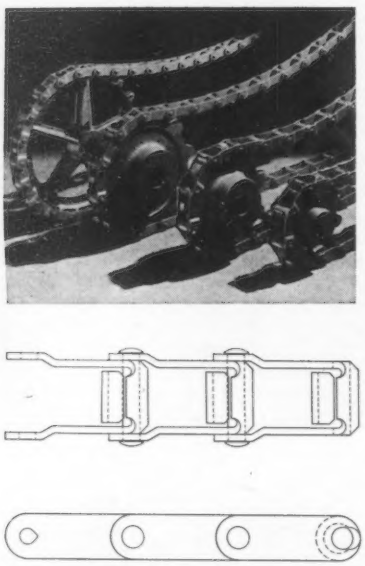




Turnover Conveyor Belt with Automatic Twist (43)

NEW "TURNOVER" CONVEYOR BELT SYSTEM that allows belts to twist themselves automatically—reversing top and bottom surfaces after delivering and before accepting a new load—has been developed by B. F. Goodrich Industrial Products Co. Goodrich's system prevents buildup of tacky materials on idlers or pulleys and can be applied to any conventional conveyor system now in operation, without altering the framework.

According to the company, twisting is accomplished by placing two twist pulleys at each end of the belt flight.

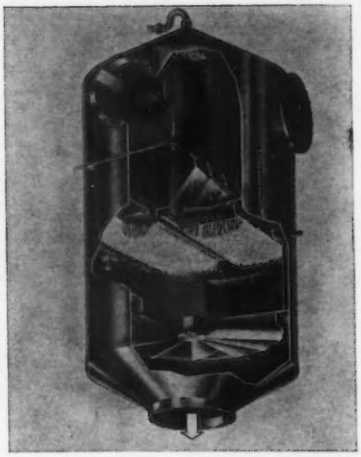


Improved Pintle Chain (8)

NEW TYPE STEEL pintle chain which offers the advantages of the standard pintle chain at cost savings—result of a patented design and automatic forming and assembly methods—is now being marketed by the Locke Steel Chain Co.

Locke calls it the "600" series and claims it is designed for use where adverse operating conditions, low maintenance requirements or use with cast sprockets are governing factors. It is especially useful in applications requiring capacities exceeding those of steel detachable chain, where more costly roller chain or malleable pintle chain might ordinarily be specified.

The "600" chain is produced in four sizes—662, 667, 667-H and 672—to standard steel detachable chain pitches, and is formed to exceptionally close dimensions and uniform pitch. In addition to the plain steel pintle chain, a number of attachment links are available for conveying applications.



AFTER BEING pressured into inlet, dust or fume-laden gas passes upward through humidifying spray, and is then pulled through the perforated plate where it is divided into thousands of individual jets. At the same time, water (or other liquid) flows uniformly over the entire plate area.

Jet stream strikes the wetted impingement surface directly above and the dust in each jet is thoroughly saturated by the pounding against the various grid surfaces together with the turbulence caused by the interaction of gas pressure and liquid flow. Slurry flows into the water seal and then down through the water outlet at the bottom of the case.

Easy-to-Maintain Scrubber (1)

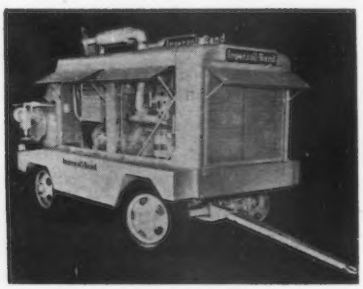
HIGH EFFICIENCY scrubbing action and low operating and maintenance costs are possible with a new line of impingement-plate scrubbers from the W. W. Sly Mfg. Co.

The inlet of Sly's single-stage scrubber handles dust loadings of up to 100 grains per cu ft. Scrubbing is done by the turbulent interaction of gas and liquid—accomplished by the stainless steel impingement baffle plate. The unit can remove suspended materials in a gas stream that range from submicron fumes to dust particles in the larger micron sizes, with more than 99% efficiency on many types of dust.

Sly said that because of the unit's simple design, pressure drop and resulting power requirements are low. Liquid consumption is only one to three gal per 1,000 cfm at 20-40 psig. Maintenance costs are kept low—no moving parts in the scrubber—and the units can be fitted into round or rectangular casings for any particular installation space.

Ribbed Bucket Tooth (6)

GENERAL METALS CORP. has developed a bucket tooth which has ribbing along the zones of quickest wear—the corners. They call it the new 8027 Dragon Tooth and claim that the ribbing maintains straight cutting edges, and keeps a cutting edge almost to the point of complete destruction.



Cycloidal Compressor (40)

INGERSOLL-RAND'S new 1200 cfm portable compressor is no larger than a 900 cfm unit and is actually half a ton lighter—weighs 14,000 lb.

The compression is done by cycloidal rotors driven by a new General Motors 12V71 diesel engine. As rotors spin at high speed, the lobes and grooves roll into each other, and the mating pockets of air are joined and compressed by positive displacement. I-R said that although similar smaller capacity machines have been available in Europe, their unit contains many improvements to give it high capacity per lb compressor weight.

Low-Set Vibrating Screen (4)

ALLIS-CHALMERS' new horizontal vibrating screens are designed in such a way that the motor base and tubular cross member are an integral part of the screen's frame.

The advantages of this arrangement, according to the company, are: elimination of an overhead structure; reduced head room; increased belt life due to close fixed centers between motor and mechanism; shorter belt which overcomes whipping wear.

For Your Files

This selected manufacturer's literature is free unless otherwise specified. If item is for sale, send request and money direct to manufacturer.

GEOTECHNICS & RESOURCES INC. is "a private enterprise in applied and theoretical study of the earth and its environment." The firm's organization, scope and method of approach to various assignments is described in a 32-page booklet.

Geotechnics does no engineering design work. It provides basic information and data that planners, engineers, and designers can put to more specific problems. Major fields in which the company's services may be used are: geoscience (geology, geophysics, petrology); planning (townsites); civil engineering (roads, tunnels, subsurface storage, railways); water technology (drainage, groundwater, infiltration and runoff); and what Geotechnics calls space sciences (terrain analysis, configurational mapping, and remote subsurface techniques). **(85)**

PAGE ENGINEERING CO. has published a brochure to describe the AUTOMATIC dragline buckets in the four to seven-cu yd range. The two-color, four-page brochure describes the two series of buckets; one for general purposes (for general contracting where a wide variety of materials is encountered) and the other for heavy duty (hardpan, blasted rock, shale, etc.). **(86)**

SWIFT REPLACEMENT of machine components at only the cost of repair is the main advantage to equipment owners of the Parts Assembly Exchange Program described in "Avoid Delay the Modern Way", a new booklet from Caterpillar Tractor Co.

Here's how Caterpillar's system works. A machine owner orders a needed replacement from his dealer. The dealer delivers the rebuilt component, taking the customer's unit into the shop to be put in working condition. The owner then is billed for repair on his old unit—about the same as if he had repaired the assembly himself. Caterpillar said the exchange assemblies are sold as "Bonded Buy" units—guaranteed in writing and backed by a $5,000 bond. **(87)**

WORLD'S LARGEST truck crane, the 890-TC, is fully described and illustrated in a 12-page technical portfolio from the Harnischfeger Corp.

The booklet contains capacity charts, general dimension drawings, a crane range diagram, cutaway photographs and photos of the 890-TC at work. **(88)**

NEW 16-PAGE BULLETIN from Reliance Electric & Engineering Co. describes its Reeves AIRtrol system and explains how drive speeds of machines and processes can be automatically controlled and regulated by simple pneumatic instrumentation.

Concise drawings show that AIRtrol can be applied to control liquid level, line pressure, process temperature, constant flow, steam pressure and motor loading.

The company said that a number of pneumatic control systems are possible—including manual remote, automatic open loop, automatic closed loop, and multi-unit systems. **(89)**

THREE COMPREHENSIVE technical portfolios covering features and capabilities of the recently-announced P&H Models 525, 535 and 550 crawler cranes are now available from Harnischfeger Corp.

The two-color presentations include information on two Harnischfeger exclusives, Power Box design and Magnetorque swing system, plus complete operating specifications of each front-end attachment, and detailed descriptions of other mechanical components. Portfolios are made up of 14 pages each for the Models 525 and 550, and 12 pages for the Model 535. **(90)**

PRODUCT AND SERVICES of Hodag Chemical Corp. are described in their new 20-page brochure. The publication also describes and illustrates Hodag's laboratory and manufacturing facilities. **(91)**

COMPLETE LINE of Reeves Vari-Speed Motodrives, ¼ through 40 hp, is presented in an 88-page catalog from Reliance Electric & Engineering Co.

Reeves Vari-Drive Motodrive is a self-contained variable speed drive unit. It includes an ac motor, variable pitch pulleys, and a gear reduction unit, when specified, in a single compact housing. **(92)**

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ENGINEERING & MINING JOURNAL
330 WEST 42nd STREET
NEW YORK 36, N. Y.

E&MJ NOT GOOD AFTER NOVEMBER 1, 1961 **MAY 1961**

Please send me the catalogs or further information about the items from New Products Digest whose numbers are circled.

1	11	21	31	41	51
2	12	22	32	42	52
3	13	23	33	43	53
4	14	24	34	44	54
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64	68	72	76	80	84	88	92	96	100

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No. 1

THE MELLON INSTITUTE has just released a special report on "The Oxidation of Pyritic Conglomerates" by S. A. Braley.

According to the author, "the purpose of the investigation is to determine the nature of the oxidation reaction responsible for the most serious pollutional property of mine discharge water, acid; also, to explain the extremely variable composition of the various discharges."

Mr. Braley's detailed 32-page report is concerned mainly with the reaction of naturally occurring sulfuritic materials found in coal measures and the adjacent geologic strata, with atmospheric oxygen, and his experiments demonstrate the time factor in acid formation and changes in composition of water extracts as related to time. **(93)**

GOULDS PUMPS, INC. is introducing a new line of single stage centrifugal pumps which provide the optimum in interchangeability of pumps and parts. The company's 16-page Bulletin No. 725.8 gives bearing life, shaft deflection data, a frame selection chart, as well as usual performance, specifications, construction details and dimensions.

Specific advantages of the pumps' modern design, Goulds said, are: 1) maximum dimensional interchangeability between all pumps, with one overall length for all sizes; 2) top centerline discharge that is self-venting and that simplifies piping; 3) back pull-out design that enables easy replacement of parts most subject to wear or damage without disturbing pipe connections or motor mounting. **(94)**

LONG-AIRDOX CO. has come out with the first issue of its magazine, "Pillars & Portals" featuring a new feeder-breaker that is designed to limit lump size feeding on the belt conveyor for easier haulage. The four-page issue also gives a case history on the company's "Full Dimension Mining" system, new product stories, and personnel announcements. **(95)**

SIX-PAGE fold-out from Spencer-Safford Loadcraft, Inc. describes the Hydra-Shift Pay-Pac dump trailer which: attains maximum legal payload in every state; allows interstate operation without changing equipment; permits ready interchangeability of tractor equipment; and has ground-hugging stability throughout the dumping cycle.

According to the company, the exclusive Hydra-Shift dump body positions on extra-length chassis for maximum weight distribution during transport and slides to rear for dumping operations. **(96)**

OHMART CORP. has published a six-page two-color fold-out to describe details of basic systems using nuclear gages for controlling specific gravity or density and liquid or interface levels.

Fundamental ideas of using gamma radiation are described as well as components required for a complete system. Methods of zero suppression, use of associated instruments, temperature regulation, safety, calibration and maintenance are also detailed. **(97)**

BROWNING MFG. CO. has released Catalog GC-101-F to illustrate and describe their complete line of power transmission equipment. The catalog contains a description and listing of thousands of stock parts available for immediate shipment. Browning said the catalog presents the most complete line of V-belts, including such associated items as wide range variable speed belts, poly-V belts, and gearbelts. **(98)**

NEW CM11 SERIES multiple unit valves for use on hydraulically operated mobile equipment are described in the eight-page Bulletin M-5112 from Vickers Inc., Div. of Sperry Rand Corp.

Vickers says the CM11 valves are available in any number of sections up to 10, with individual load checks in each section. They are rated for operation to 2,500 psi. Features include improved metering, reduced leakage from cylinder to tank, and reduced pressure drop. Nominal flow rating is 15 gpm; higher flow rates are possible with pressure drops acceptable to the operator. **(99)**

AMERICAN AIR FILTER CO. has released a new product bulletin (No. 160-C) describing its low resistance Model C Type P Cycoil industrial oil bath air cleaner with what American calls "the revolutionary pneumatic oil lift."

The bulletin discusses proper maintenance procedures, oil recommendations, filter cell service, model size selections, and the efficiencies and dust-holding capacities of the air cleaner.

Detailed drawings illustrate the component parts, their construction and action. **(100)**

E&MJ NOT GOOD AFTER NOVEMBER 1, 1961 **MAY 1961**

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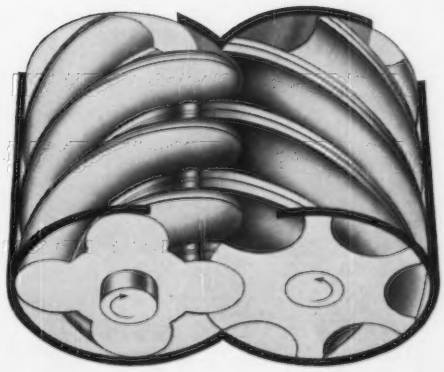
Here's the world's FIRST single-engine

1200 cfm

portable air compressor



ADVANCED DESIGN CYCLOIDAL COMPRESSION

This illustration shows the cycloidal rotor method of compressing air. As the lobes and grooves roll into each other, the mating pockets of air are joined and compressed. This design is similar to that of the Ingersoll-Rand Axi-compressor which has been in use for several years for stationary service. New refinements and design features make it ideally suited for large-capacity portable units.

Now, for the first time, you can meet your requirements for large blocks of air power with a compact, single-engine-driven compressor that's *truly portable.* For Ingersoll-Rand's advanced design 1200-cfm portable is no larger than a 900-cfm unit, and actually weighs 1000 pounds *less!*

Driven by a single General Motors 12V71 diesel engine, this new machine utilizes a compact, light weight cycloidal compressor with only two moving parts. It gives smooth, pulsation-free positive-displacement compression with a new high in capacity per pound of compressor weight.

Ask your Ingersoll-Rand engineer or distributor for complete information.

Ingersoll-Rand®

258A2 11 Broadway, New York 4, N. Y.

THE WORLD'S MOST COMPREHENSIVE COMPRESSOR EXPERIENCE

The newest reason to make your next tandem a FORD:

'61 FORD HEAVY DUTIES

GIVE TWICE THE CAB, FENDER AND RADIATOR LIFE!

Rugged Ford Heavy Duties utilize heavier gauge steel, sturdier reinforcements, and a new independent mounting system to separate cab, fenders and radiator. This stronger construction, with each component *individually* frame-supported, doubles cab, fender and radiator life—cuts downtime delays and maintenance expense.

CAB—A 25% heavier floor pan and toeboard provide a solid base for greater cab durability. New full-length door pillar reinforcements and stronger inner door panels minimize door sag. New triangular mounts keep cab level and protect it from frame-movement stresses.

FENDERS—Ford fenders are 25% heavier gauge, too. They are bolted to a rubber-cushioned transverse support in front for needed flexibility. Fender-wide rear brackets provide necessary rigidity. The removal of only 8 bolts permits pulling the fender for rapid access to engine.

RADIATOR—New Ford "lock-seam" construction doubles the solder area on key seams, and heavier gauge tank and header walls provide increased radiator strength. "Horse collar" mounting on rubber pads soaks up vibrations and diagonal braces at sides give solid support.

Ford's separate mounting of cab, fenders and radiator frees them from frame-movement stresses that occur when these parts are rigidly attached to each other. Result: failures and service costs are reduced even in tough off-road operation.

Ford T-Series tandem rear axle trucks and tractors are available with GVW's up to 51,000 lb.—GCW's up to 75,000 lb. Your choice of Timken or Eaton axles with up to 38,000 lb. tandem capacity. Seven exclusive-truck V-8 engines range from 302 to 534 cubic inch displacement.

SEVEN MORE REASONS WHY IT'S GOOD BUSINESS TO DO BUSINESS WITH FORD!

You save from the start with Ford's traditionally low prices, and your savings continue with low operating and maintenance costs. These facts are documented by certified test reports from America's foremost independent automotive research firm. Ask to see these reports. They're on file at your Ford Dealer's.

In addition to these dollar-and-cents savings, the following bonus benefits are yours with Ford Trucks:

1. **Rigid quality controls** give you the strongest safeguard of truck reliability ever. Modern, *exclusive-truck* manufacturing facilities, with emphasis on quality every step of the way, are designed to give you a Ford Truck that is as free from defects as a truck can be. Tangible results of these high standards are Ford's new warranties.

2. **Exclusive 100,000-mile warranty** (or 24 months) on 401-, 477- and 534-cu. in. Super Duty V-8's is the most liberal in the industry. Each major engine part (including block, heads, crankshaft, valves, pistons, rings), when engine is used in normal service, is warranted by your dealer against defects in material or workmanship for 100,000 miles or 24 months, whichever comes first. The warranty covers full cost of replacement parts . . . full labor costs for first year or 50,000 miles, sliding percentage scale thereafter.

3. **12,000-mile warranty** (or 12 months) on all 1961 Ford Trucks of every size is further evidence of the confidence Ford has in its quality controls. Each part, except tires and tubes, is now warranted by your dealer against defects in material or workmanship for 12 months or 12,000 miles, whichever comes first. The warranty does not apply, of course, to normal maintenance service or to the replacement in normal maintenance of parts such as filters, spark plugs and ignition points.

4. **Special fleet financing** can be arranged by your Ford Dealer. It's available for owners of two or more trucks, and provides the opportunity to precisely tailor payments to your income patterns or depreciation schedules. This fleet-fitted financing offers substantial savings and frees your working capital.

5. **Sales engineers and service specialists** in 36 district offices are on call to solve special truck problems. Working with both dealers and customers, these experienced truck men represent another extra step Ford takes to provide your continued satisfaction.

6. **Replacement parts depots** at 26 strategic locations across the country quickly supply needed parts from ample stocks. Ford's entire supply system is geared to give you faster service and reduce costly downtime . . . *wherever* you are.

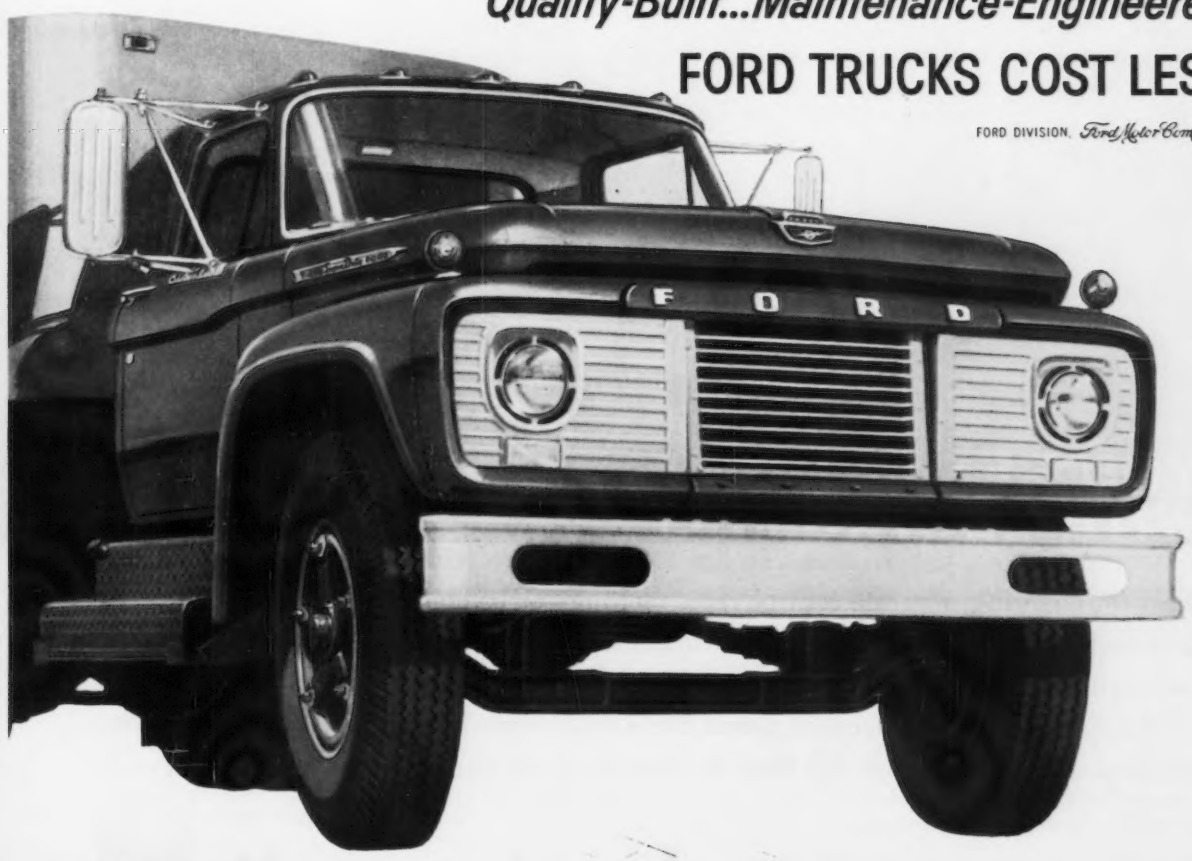
7. **6,800 Ford Dealers,** including 280 specialized Heavy Duty truck dealers, can keep your trucks ready to go wherever they go. From coast to coast, fast Ford service—gas *and* Diesel—is always close at hand.

From Super Economy pickups to Diesel-powered tractors, you can now fill every truck need up to 76,800 pounds GCW with a modern, money-saving Ford Truck.

Quality-Built...Maintenance-Engineered

FORD TRUCKS COST LESS

FORD DIVISION, *Ford Motor Company*



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Fast top charging, accurate control, rapid melting—all combine in a Lectromelt furnace to give high availability. Lectromelt furnaces have the ability to take it, while also maintaining high quality, when you pour on the power to get top production. Catalog 10-A describes these furnaces in detail. For a copy, write Lectromelt Furnace Division, McGraw-Edison Company, 322 32nd St., Pittsburgh 30, Pennsylvania.

A DIVISION OF THE GROWING McGRAW-EDISON FAMILY

Lectromelt

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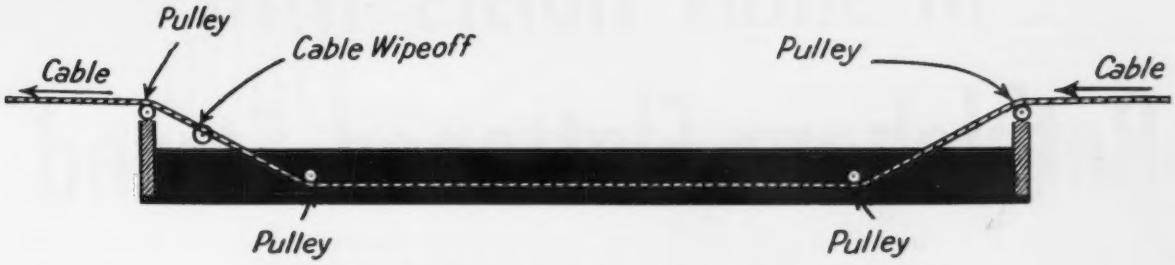
LUBE LOGIC

2 new ways to trim downtime



Warm bath restores wire rope

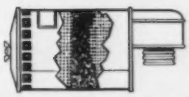
The best way to get lubricant inside a cable, where it's really needed, is to immerse the cable or wire rope every 500 hours or so in a bath of warmed-up Crater A lubricant. It pays off by giving you far longer service life than you would get simply by applying Crater A externally. This warm-bath treatment requires a horizontal trough to hold the lubricant. The trough should be fitted with pulleys to keep the cable completely submerged while it's passing through. A burlap collar should be rigged to wipe off excess lubricant as the cable leaves the box. An immersion of about a minute will allow the lubricant to work well into the strands.

This process is *not* an alternative to other lubrication. You should continue to clean the cable and apply Crater A externally every 10 to 100 hours, depending on the type of work the cable is doing. Remember also to be very sparing with lubricants on cables that wind on clutch-equipped drums, and never lubricate cables that are dragged in dirt.

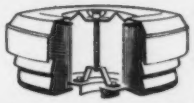
Key points on air filter maintenance

In a day's operation a typical engine inhales several thousand cubic feet of air, and in strip mining all that air is probably loaded with abrasive dirt and dust. Good air-filter maintenance is the only way to make sure your engine gets the air and not the dirt. Here are some maintenance tips that will keep your air filter working harder through thick and thin.

Oil-bath type air filters won't function properly if there's more than a half inch of sediment at the bottom of the oil reservoir. Check the sediment level by sticking a screw-driver down into the oil, and if you're anywhere near the half-inch level, the bowl should be cleaned out and refilled. Also, inspect the filter every 5 to 50 hours to make sure the oil itself is at the right level. Every 500 hours the whole cleaner should be dismantled and cleaned, and refilled with new engine oil of the same grade used in the crankcase.



Wire gauze type filter. If you want to re-use the element, wash the gauze in kerosine or diesel fuel, shake it dry (don't blow it with compressed air) and re-oil it with SAE 40 or 50 oil to coat the element.



Dry type air cleaners (the ones with the fluted paper element) should simply be shaken or tapped lightly to remove dirt, and reinstalled. Never clean dry-type elements with kerosine or diesel fuel.

Additional precautions: empty centrifugal precleaners when the glass container is half full; don't remove the oil cup when the engine is running.

TEXACO LUBRICATION ENGINEERS

Every month or so we'll bring you a batch of "sleepers"—little angles, so easy to overlook, where big savings in time and money can be made. But month in, month out, your local Texaco Man is your best source of money-saving lubrication ideas. Don't forget that "Lubrication is a major factor in cost control." Texaco Inc., 135 East 42nd Street, New York 17, N. Y.

TUNE IN: TEXACO HUNTLEY-BRINKLEY REPORT MON. THROUGH FRI.—NBC-TV

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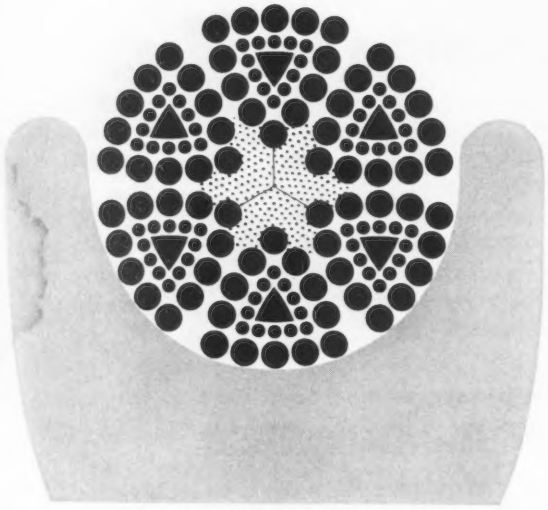
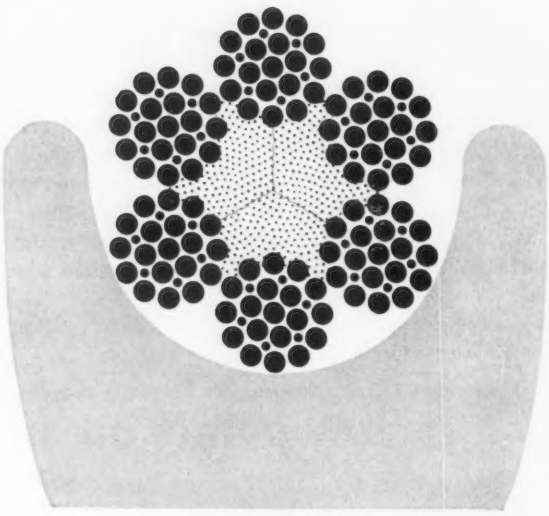
Throughout the United States Canada • Latin America • West Africa

Get longer rope life in shaft hoists with Bethlehem Flattened Strand



BETHLEHEM FLATTENED STRAND



ORDINARY ROPE

. . . it has 100 per cent more wearing surface than rope made with round strand

Bethlehem Flattened Strand resists abrasive wear and crushing more effectively than ordinary rope because more than half of the outer surface of the triangular-shaped strand makes contact with wearing points such as sheaves, drums, and spooled rope. Abrasive wear is distributed over a wider area of the rope surface than when a round strand rope is used.. In fact, the wearing surface of Bethlehem Flattened Strand is 100 pct greater than that of ordinary rope.

Another economy feature of Bethlehem Flattened Strand: its smooth surface helps to minimize wear on drums and sheaves. It is furnished in 6 x 27 and 6 x 25 types, lang lay, Form-Set, and with either fiber core or IWRC.

For complete information get in touch with your Bethlehem wire rope distributor. Or write us at Bethlehem, Pa.

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Export Sales: Bethlehem Steel Export Corporation

There's a distributor of Bethlehem Rope near you, supplied by our nationwide network of wire rope mill depots.

Steel

for Strength
. . . Economy
. . . Versatility

BETHLEHEM STEEL

BETHLEHEM STEEL

How the clam-action 4-in-1 gives you

'equipment spread' utility...

with a one-man "crew"!

Move the "machine action" selector lever—see for yourself how the International Drott 4-in-1 gives you equipment spread utility with a one-man "crew"—does dozens of jobs, other excavator-loaders can't touch! Prove that the 4-in-1 saves you the expense of buying or renting additional machines, and of hiring extra operators. Let your International Drott Distributor demonstrate!

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Drott Manufacturing Corp. Milwaukee 15, Wisconsin

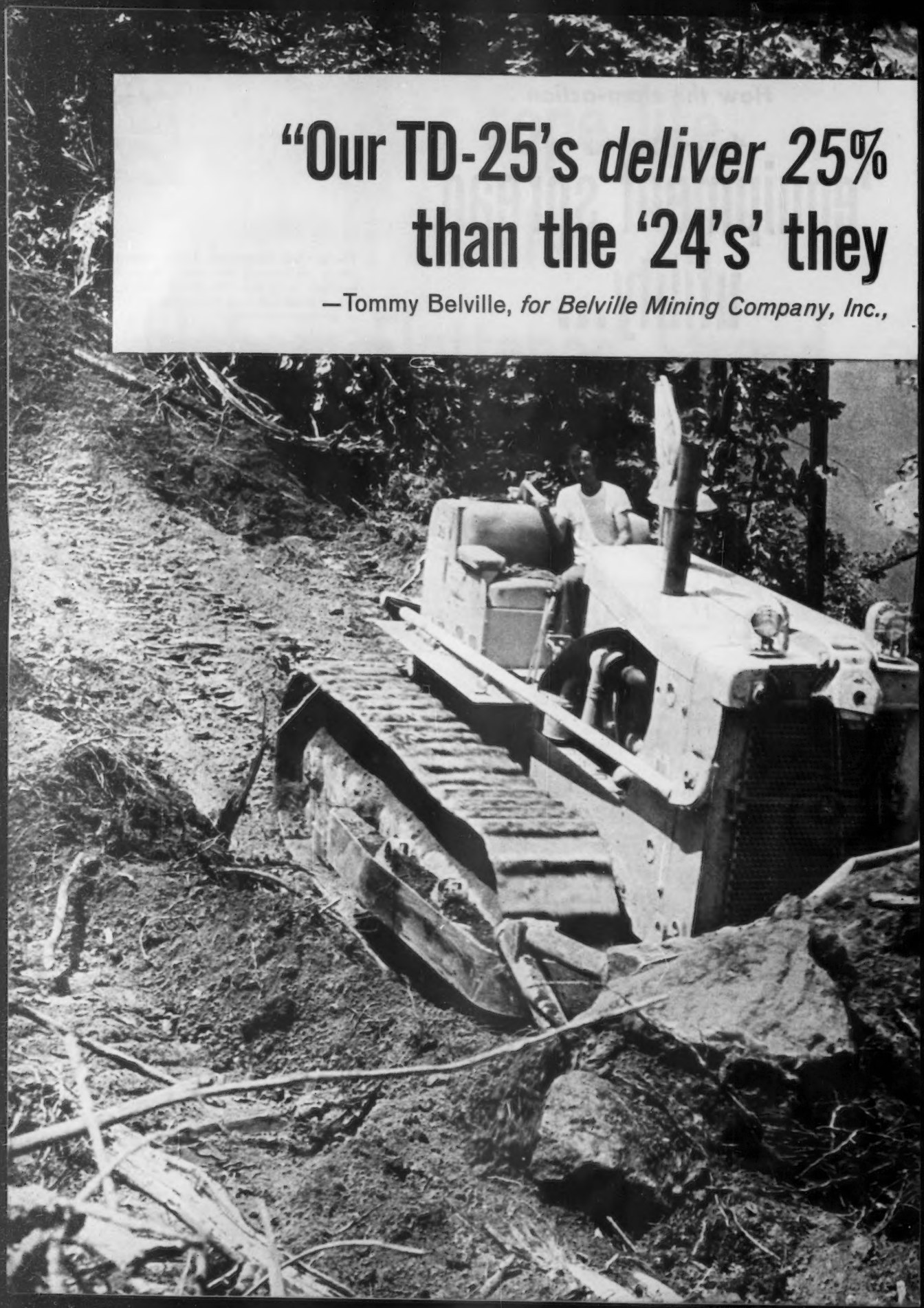
INTERNATIONAL DROTT

You get a full-capacity, earth rolling bulldozer simply by opening the 4-in-1's clam—with 2-finger hydraulic lever ease. This TD-15 Four-in-One is clearing off brush and removing overburden from a deposit of sub-base materials.

Let the 4-in-1 double for a boom-type shovel in many conditions—as this operator does. Here, his 1⅛ cy. yd. TD-6 Four-in-One applies famous pry-over-shoe break-out action and "doubles for dynamite" to dig hard materials without shooting.

End sticky materials problems for good, the way dredging contractors do: with positive clam-action bottom-dumping. Note how opening the 4-in-1's clam pulls materials from bucket surfaces—and gravity down-pull does the rest—to enforce positive, self-cleanout dumping.

You can back-drag materials wholesale (and safely) from the sand, clay, or gravel bank. And use this same action to grab, carry, and load heavy, unwieldy "impossibles" including stumps, boulders, and slabs of rock—without delay or extra help!



"Our TD-25's *deliver* 25% than the '24's' they

—Tommy Belville, *for Belville Mining Company, Inc.,*

more load replace"

Ironton, Ohio

"Our three International TD-25's are delivering 25% additional load, compared with previously-owned TD-24's," reports Belville Mining Company, Inc. "The TD-25 has more power to work at faster speeds without loss of motion.

"Another big advantage of the TD-25, mighty important in outcrop cutting, is you can back it up extreme grades at the faster speeds without changing gears."

"Belville" teams "25's" with a 7-cu yd dragline and a 2½-cu yd stripping shovel—to remove overburden as deep as 60 feet. The tractors are also used to level for the shovels, clean coal, construct roads.

"Live track" power-steering!

Like the TD-24, the TD-25 gives you exclusive "live track" Planet Power-steering—to make full-load, full-power turns, or slam straight ahead with offset loads. With combined on-the-go, HI-Lo power-shifting, you get instant, up-or-down matching of power to condition.

You turn with the dozer fully loaded, without spillage. You get constant-contact benching or highwalling, applying full power, getting full speed. You eliminate "dead-track drag" and "gear-shift lag."

With exclusive new International DT-817 Diesel engine wallop, the "25" bulls along, 230 turbocharged hp strong—without "slow-motion" lug-downs. New TD-25 seven-roller tracks are strength-matched to full engine effort. And the "25" is platformed on super-rugged double-box-beam frames to meet slam-bang conditions!

See what it means in extra profits to beat the famous TD-24 by 25% or more. Compare planet-drive "25" ability to outearn king-size clutch-steered rigs by amazing margins—clearing land, blading rock, benching, mass-production overburden removal. Let your International Construction Equipment Distributor demonstrate.

Benching an access road on a 1-to-1, or steeper, mountain slope. The operator of this Belville-owned TD-25 takes maximum advantage of "live track" Planet Power-steering—to gouge out stumps and boulders and cut shale—without "bank-nosing" or sluing. He simply operates the bank-side track in high-speed range, the other in low-speed range—for full-capacity, straight-ahead performance.

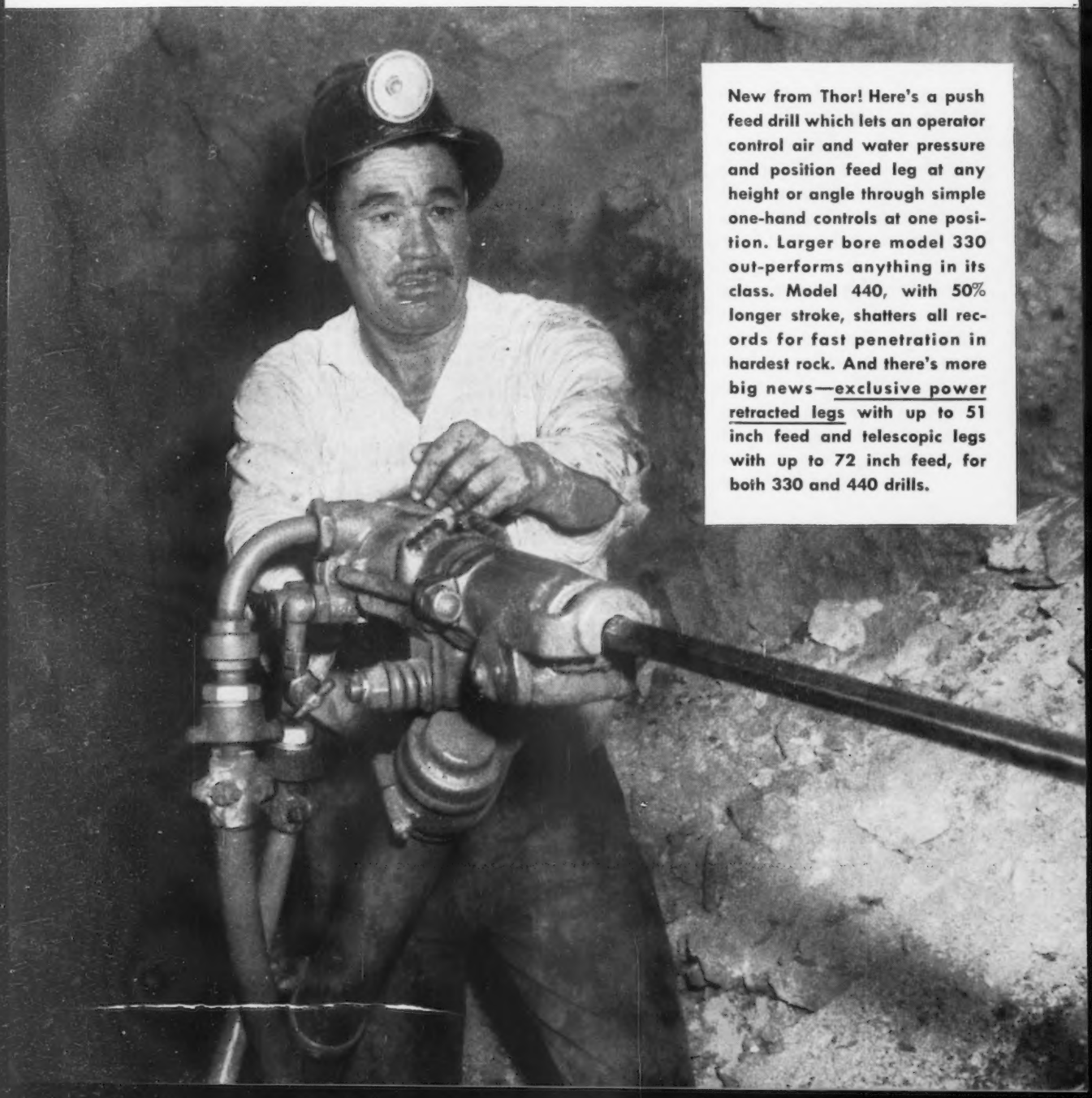
International®
Construction
Equipment

International Harvester Co.,
180 North Michigan Ave., Chicago 1, Illinois
A COMPLETE POWER PACKAGE

Two of "Belville's" TD-25's remove up to 50% of the overburden from a coal seam—produce 25% more than the "24's" replaced. Only simplified TD-25 planetary design gives you "live track" power-steering and on-the-go power-shifting.

New power retractable and telescopic legs
for faster penetration, increased tonnage

THOR AIR ROCK DRILLING EQUIPMENT



New from Thor! Here's a push feed drill which lets an operator control air and water pressure and position feed leg at any height or angle through simple one-hand controls at one position. Larger bore model 330 out-performs anything in its class. Model 440, with 50% longer stroke, shatters all records for fast penetration in hardest rock. And there's more big news—exclusive power retracted legs with up to 51 inch feed and telescopic legs with up to 72 inch feed, for both 330 and 440 drills.

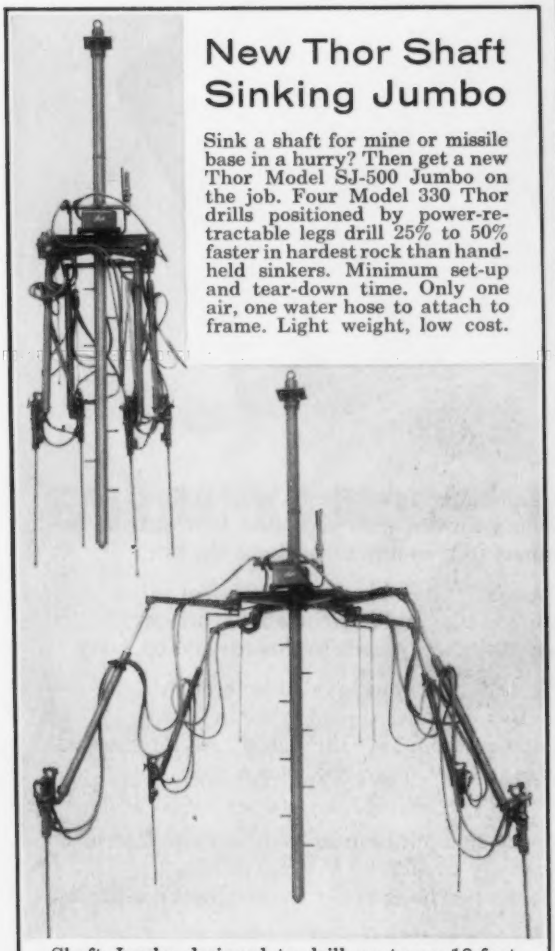
You'll find modern Thor rock drilling systems continually at the forefront of important mining and quarrying jobs everywhere. Why? Reason's simple. Innovations in world famous Thor equipment see to it your drilling speed is increased, power is balanced, performance smooth, air economized, maintenance held to a minimum. And all for a bigger profit picture for you, less fatigue to your operators. Demonstration? Your Thor "Red Tool" distributor and your nearest Thor factory representative are in the Yellow Pages. Or write us. Thor Power Tool Company, Aurora, Illinois.

MEASURED AIR means fastest footage. Thor's model 75 hand-held rock drill sinks holes up to 20 ft. in hardest rock. Wet or dry operation. Exclusive Thor air valve admits exact amount of air required, assuring maximum economy.

"PAID FOR ITSELF on roof bolting operations alone," that's what an underground quarry operator had to say about Thor's TR-5 crawler rock drill. Rigged with extended boom, the Thor crawler drilled up to 200% more holes per day than competitive models.

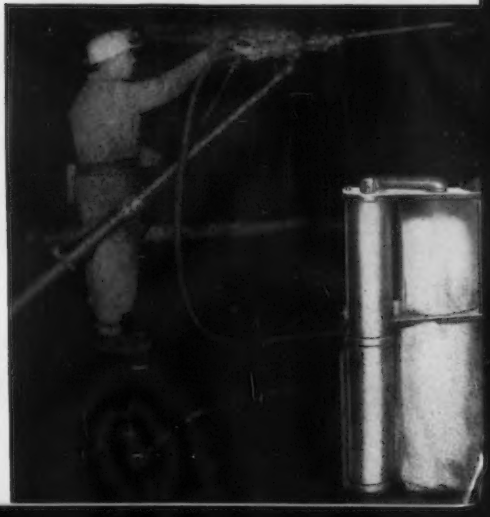
New Thor Shaft Sinking Jumbo

Sink a shaft for mine or missile base in a hurry? Then get a new Thor Model SJ-500 Jumbo on the job. Four Model 330 Thor drills positioned by power-retractable legs drill 25% to 50% faster in hardest rock than hand-held sinkers. Minimum set-up and tear-down time. Only one air, one water hose to attach to frame. Light weight, low cost.



Shaft Jumbo designed to drill up to an 18-foot diameter. Easily folds to pass through a 4-foot by 4-foot compartment. Frame provides support and all necessary power. Pneumatic support column maintains correct upright position.

DRY, DUSTLESS AND DYNAMIC sums up the new Thor model 390-DL dustless push feed drill. Dust and fragments are siphoned off by high velocity reversed air action through the hollow steel. No mess, more production, longer bit life.



Thor POWER TOOLS

THOR POWER TOOL CO., AURORA, ILL.

ATLANTA • BIRMINGHAM • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DENVER
DETROIT • HOUSTON • INDIANAPOLIS • KANSAS CITY, MO. • LOS ANGELES • MILWAUKEE • NEWARK
NEW YORK CITY • PHILADELPHIA • PITTSBURGH • RICHMOND • ST. LOUIS • SAN FRANCISCO
SEATTLE • TORONTO, ONT., CAN. • EXP. DIV., NEW YORK CITY

V-R

PERCUSSION BITS...

with threads to fit your steel!

1. Precision machined threads provide the perfect matched fit with your steel that distributes the impact load evenly throughout the bit.

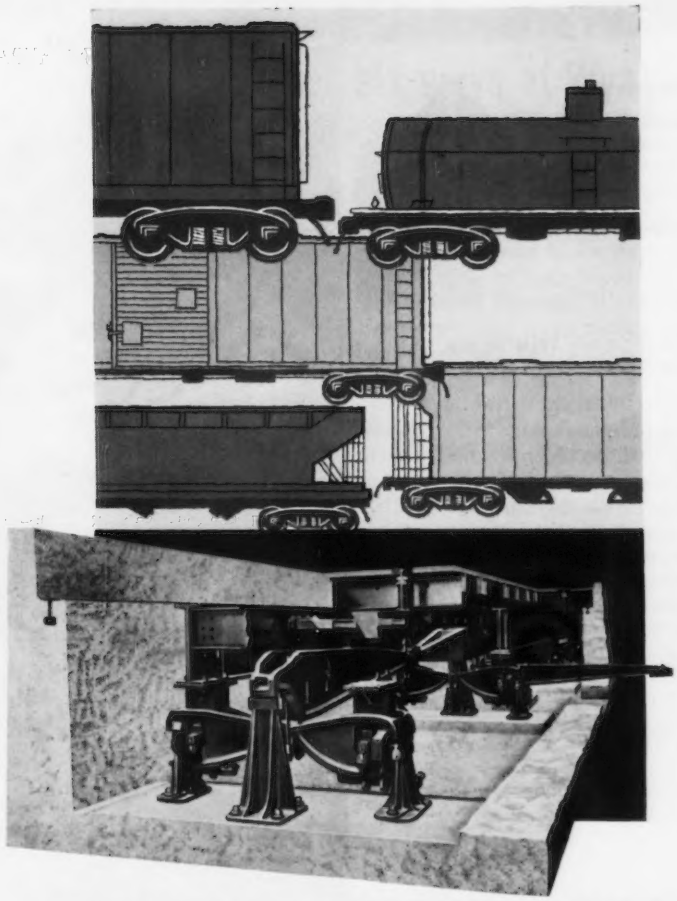
2. A special fatigue-resistant alloy steel, made to exacting V-R specifications, brings greatest possible strength to threads and bit body.

3. V-R's complete line, available through distributors, includes thread types in bit diameters from 1⅜" through 6". All bit sizes are available in the Cross Style, plus a wide selection in the "X" Style.

4. Impact- and abrasion-resistant carbide inserts are especially created by V-R for drilling fast, clean blast holes under the toughest conditions.

Write for new percussion bit catalog —
VASCOLOY-RAMET CORPORATION
830 Market Street, Waukegan, Illinois

V-R **FIRST CHOICE of more and more drillers**



OUR TYPE "S" LEVER SYSTEM WEIGHS MORE R. R. CARS THAN ANY OTHER SCALE!

FAIRBANKS-MORSE RAILROAD TRACK SCALES

Obviously there's a reason more cars are weighed on Fairbanks-Morse Track Scales. The reason is that these precision scales are more accurate—and remain so for longer periods of time.

Behind this accuracy is Fairbanks-Morse's exclusive Type "S" Lever System with Double Parallel Link Suspension. This is the only system which swings parallel to the direction of traffic . . . and thus provides the finest protection for the scientifically ground and machined pivots and bearing . . . thus, the greater accuracy.

This accuracy . . . and the dependability of these scales—backed up by 131 years of precision craftsmanship—explains why increasing numbers of shippers, manufacturers, miners and processors are insisting on Fairbanks-Morse for the day-in, day-out rapid weighing of full-capacity railroad cars.

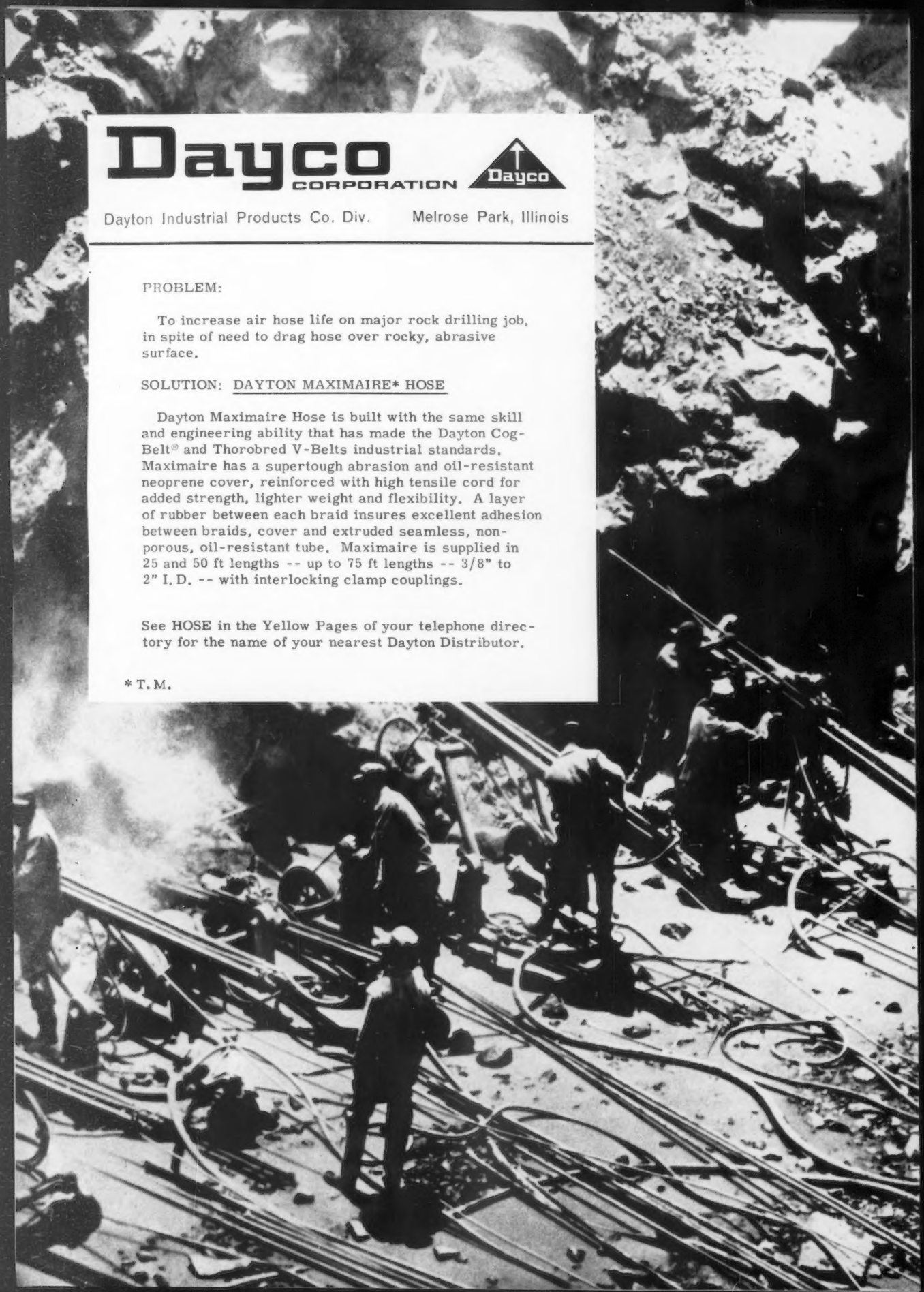
Because these scales are so conservatively rated, consistent use at their maximum capacity cannot affect their accuracy and long life. Models are available in any length or capacity to meet modern shipping requirements. Use of a Type-Registering Weighing Beam or an automatic "Floaxial Dial" with Printer" assures clear, accurate printed records of each weighing . . . eliminates mental calculations and provides error-free reading or transposing of figures.

For further information write: **C. G. Gehringer, Director of Marketing; Fairbanks, Morse & Co.; Scale Division; 19-01 Route 208; Fair Lawn, New Jersey.**

FAIRBANKS MORSE

A MAJOR INDUSTRIAL COMPONENT OF

FAIRBANKS WHITNEY



Dayco CORPORATION

Dayton Industrial Products Co. Div. Melrose Park, Illinois

PROBLEM:

To increase air hose life on major rock drilling job, in spite of need to drag hose over rocky, abrasive surface.

SOLUTION: DAYTON MAXIMAIRE* HOSE

Dayton Maximaire Hose is built with the same skill and engineering ability that has made the Dayton Cog-Belt® and Thorobred V-Belts industrial standards. Maximaire has a supertough abrasion and oil-resistant neoprene cover, reinforced with high tensile cord for added strength, lighter weight and flexibility. A layer of rubber between each braid insures excellent adhesion between braids, cover and extruded seamless, non-porous, oil-resistant tube. Maximaire is supplied in 25 and 50 ft lengths -- up to 75 ft lengths -- 3/8" to 2" I. D. -- with interlocking clamp couplings.

See HOSE in the Yellow Pages of your telephone directory for the name of your nearest Dayton Distributor.

* T. M.

"JFI Positive Performance Feeder cuts costs six ways at Wyatt-Seanor Mine."

Says John Harvey, Superintendent, Wyatt-Seanor Mine, Simpson Coal and Chemical Corporation.

Simpson Coal and Chemical increased production *and cut costs* when they installed a JFI *positive performance* Feeder in their Wyatt-Seanor Mine in Western Pennsylvania. John Harvey, Wyatt-Seanor Superintendent, reports: "The JFI Feeder allowed us to more fully utilize belt capacity by conveying more coal at slower belt speeds—100 f/p/m *less* than before. Belt wear was noticeably reduced.

"We were also able to eliminate mainline belt spillage from the feeder point to the outside of our mine, and now there is no need to attend belt transfer points. Many man hours are being put to use at more productive jobs. Elimination of surges and overload conditions has reduced mechanical maintenance on belt drives and cut horsepower requirements on those drives."

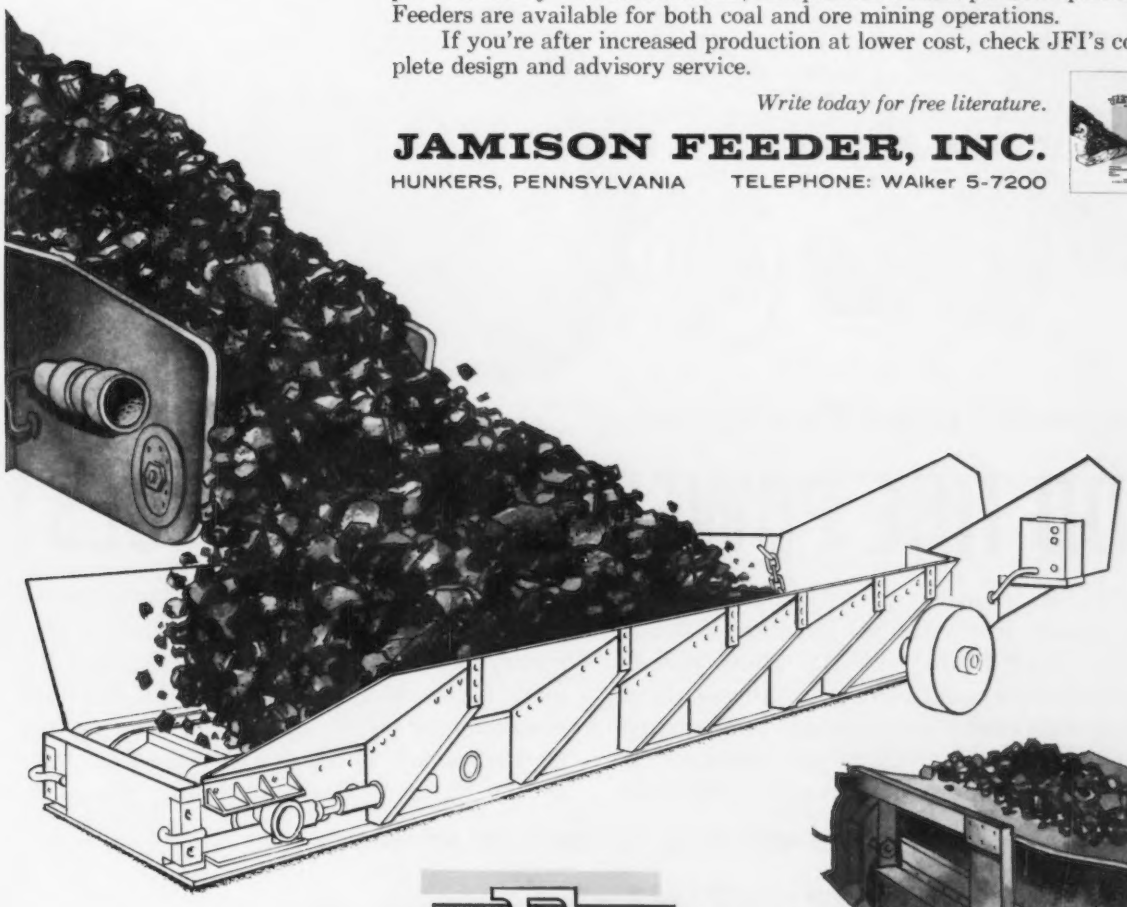
JFI *Positive Performance* allows high shuttle car discharge rate, complete flexibility of reduction ratio, and profitable multiple belt operation. Feeders are available for both coal and ore mining operations.

If you're after increased production at lower cost, check JFI's complete design and advisory service.

Write today for free literature.

JAMISON FEEDER, INC.

HUNKERS, PENNSYLVANIA TELEPHONE: WAlker 5-7200



Shock-Fortified Firestones

ADD TIRE POWER TO TASK FORCES!

You'll beat downtime and add to profits when your quarry trucks roll on Firestone SUPER ROCK GRIP DEEP TREAD* tires. Shock-Fortified nylon cord bodies armor these rugged tires against haul impact to keep your quarry equipment working. Extra cut-resistance is built into Firestone quarry tires, too, with long-wearing Firestone Rubber-X. This exclusive cord-body and rubber combination gives your quarry trucks new staying power under big loads, in the roughest conditions. Put Firestone tires on your quarry equipment—and get the backing of fast, on-the-job service—from your nearby Firestone Dealer or Store. *Firestone T.M.

Always Specify Firestone Tires When Ordering New Equipment.

Firestone

FIRST IN OFF-THE-HIGHWAY TIRE NEEDS

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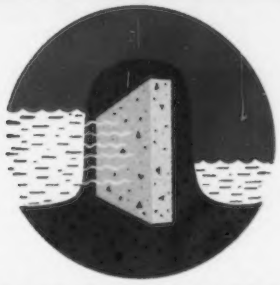
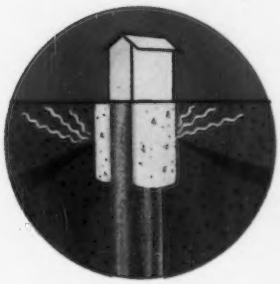
HOW HALLIBURTON GROUTING VERSATILITY SOLVED THESE PROBLEMS



WATER RESERVOIR LEAKAGE

Irvine, Ky. – A reservoir adjacent to the Kentucky River was losing considerable water through permeable stratum beneath the reservoir dam. SOLUTION: Halliburton Pressure Grouting Service was engaged to build a cutoff "wall" through the permeable stratum. Grouting holes were drilled into the permeable stratum. Halliburton DOC (Diesel Oil Cement) grout was selected because of its ability to set almost immediately when contacted by water. Water leakage from the reservoir was completely halted.



SALT MINE WATER INTRUSION

Avery Island, La. – The wall of this 15′ x 20′ ventilation and access shaft, 508′ deep, is formed of open salt except for a concrete caisson lining the top thirty feet. Water had dissolved the salt behind the concrete at the caisson base, allowing water intrusion into the shaft. The water was dissolving and eroding the walls all the way to the mine floor. SOLUTION: Halliburton studied the problem and simulated these subsurface conditions for a long series of experimental injection tests prior to presenting a grouting plan for approval. It was decided to inject Halliburton Bloxall chemical grout at unusually low pressures and volumes to effect a water-tight seal between the salt dome and overburden without adversely affecting the salt, and to consolidate the fine water-bearing sand surrounding the shaft. Two concentric perimeters of grouting holes were drilled around the shaft. Pipe was placed in the holes and perforated at carefully selected depths with Halliburton's perforating tool. Accurate injection pressures were maintained at exacting levels by Halliburton's versatile six-plunger grouting pump. Pressure tests and observation after the job determined that the shaft was dry following this treatment and indicated that the surrounding formation was consolidated.

COMPRESSOR STATION VIBRATION

Wichita, Kan. – Excessive vibration in this compressor station building and surrounding area was apparently being caused by harmonic action of the compressors plus the inability of loose sand underlying the foundation to adequately anchor the structure. SOLUTION: A pattern of grouting holes were drilled through the floor of the building and into the unconsolidated sand formation. Halliburton Chemical grout was selected because it was necessary to actually penetrate the pore spaces of the loose sand. Following the chemical grout placement through perforations, the loose sand was consolidated and tied together, thus eliminating the damaging effects of vibration on equipment and protecting gas lines leading into the building.

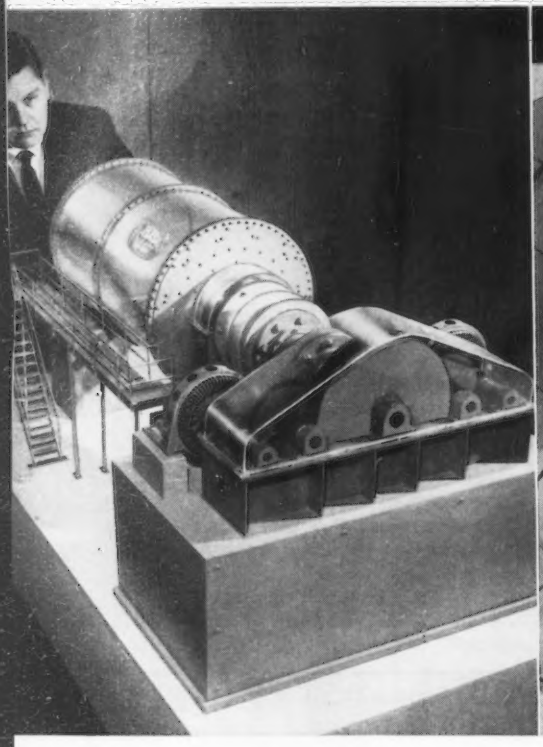
CONSULT YOUR HALLIBURTON GROUTING SPECIALIST for more details on helping you solve these and many other difficult problems with the advanced techniques of Halliburton Pressure Grouting Services. He is as near as your phone.

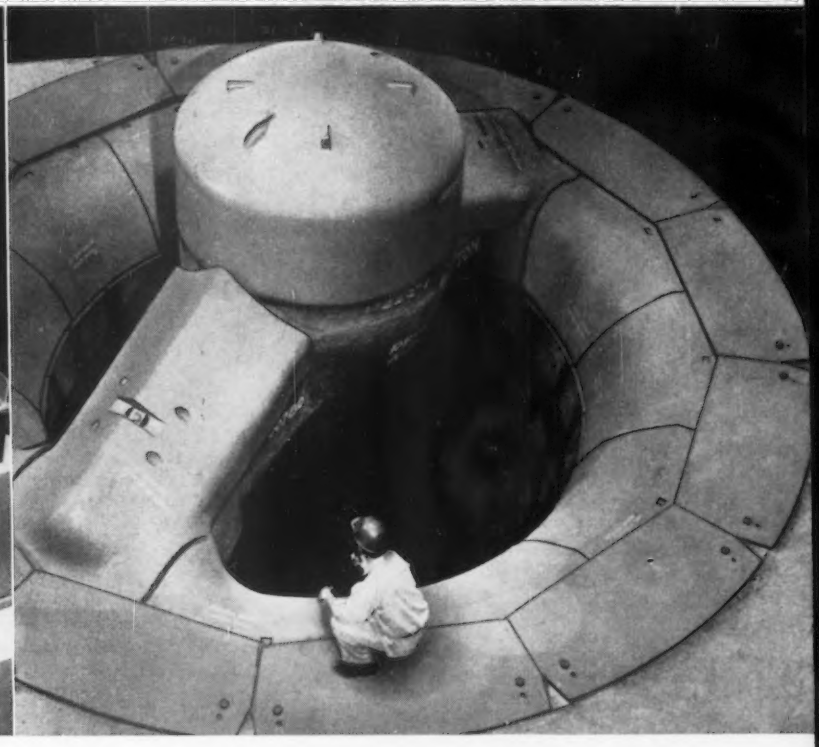
Halliburton is financially able to perform any size grouting operation as a prime or sub-contractor

PRESSURE GROUTING SERVICES

Halliburton
COMPANY · DUNCAN, OKLAHOMA

ideas and news:





Latest step in mill trunnion drive evolution: New TWINDUCER drive divides mill load electrically between twin synchronous motors. Compared to trunnion drives with mechanically divided load, the TWINDUCER drive requires 50% less space. Since there are no floating gears or pinions, gear wear is kept to a minimum. TWINDUCER drive fits any plans for automatic grinding operation.

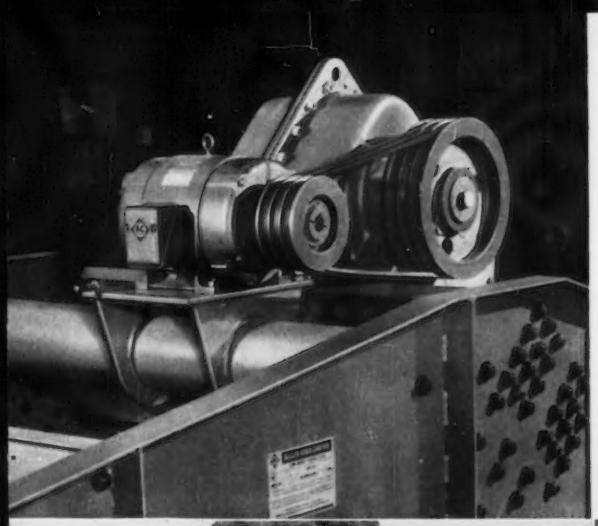
World's largest crusher to be duplicated: Because it has achieved very favorable results in expanding production and lowering operating costs, this giant Allis-Chalmers crusher will soon have a running mate. Scheduled for installation at the same ore reduction plant is an identical 60-109 SUPERIOR crusher with HYDROSET mechanism. Allis-Chalmers will also furnish two 500-hp motors, four 30-70 SUPERIOR secondary crushers, and four 300-hp motors for the installation. Drive motors and crushers are designed together . . . built together at A-C.

Which of these productive ideas could be working for you?

Larger, more efficient crushers and screens. Easily maintained switchgear. Reliable substations. These examples demonstrate the extra value that is standard with A-C . . . the greater efficiency and the added productivity which are yours when you buy A-C products, systems and services. Call your Allis-Chalmers representative for details on A-C "worth-more" features. Or write Allis-Chalmers, Industries Group, Milwaukee 1, Wisconsin.

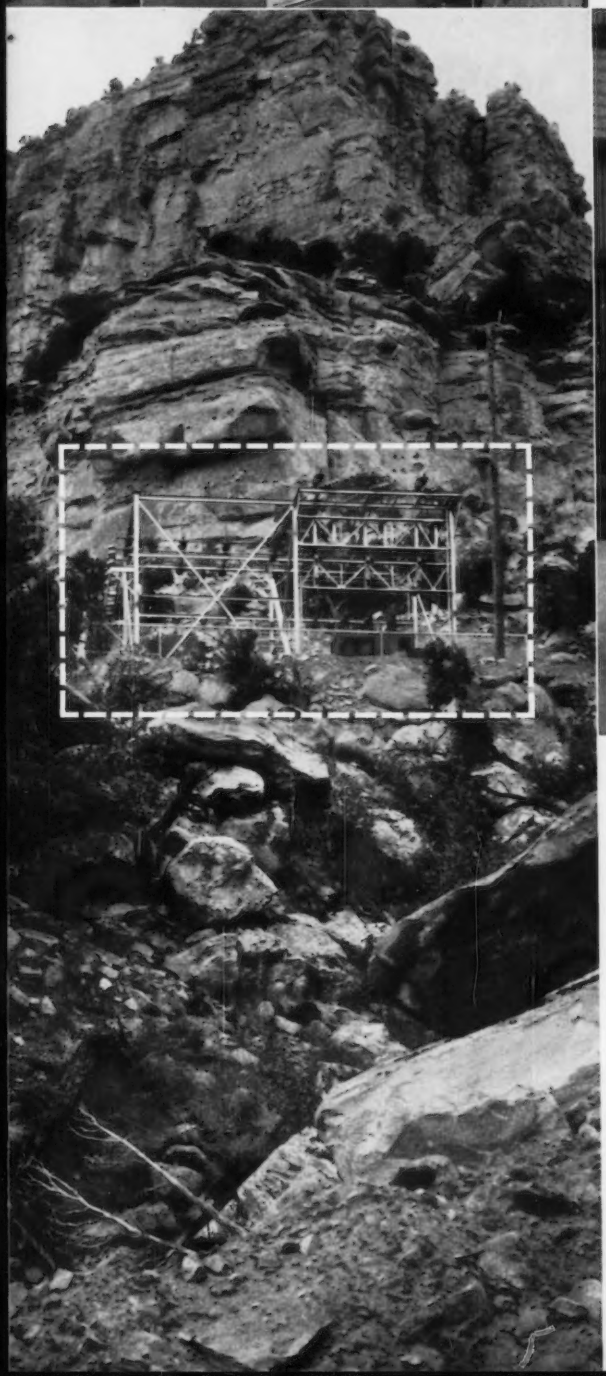
Twinducer, Superior, Hydroset and Low-Head are Allis-Chalmers trademarks.

A-1481



Low-Head screen with direct mounted motor — A completely integrated screening unit is this new, LOW-HEAD horizontal screen with direct mounted motor. No supporting structure, no belt tensioning or alignment problems plus headroom saving, smooth starts and stops, easy accessibility for maintenance. Another example of engineered screening from Allis-Chalmers.

Lowest height, easiest access 5-kv metal-clad switchgear on the market. Just 72 inches high. You get eye-level instrumentation, shoulder-height accessibility of component parts. Other outstanding advantages: front-accessible current transformers; maximum compartmentation and dead-front construction for greater safety; full-panel metering; rapid, one-stroke breaker insertion. Choice of stored energy or solenoid operation.

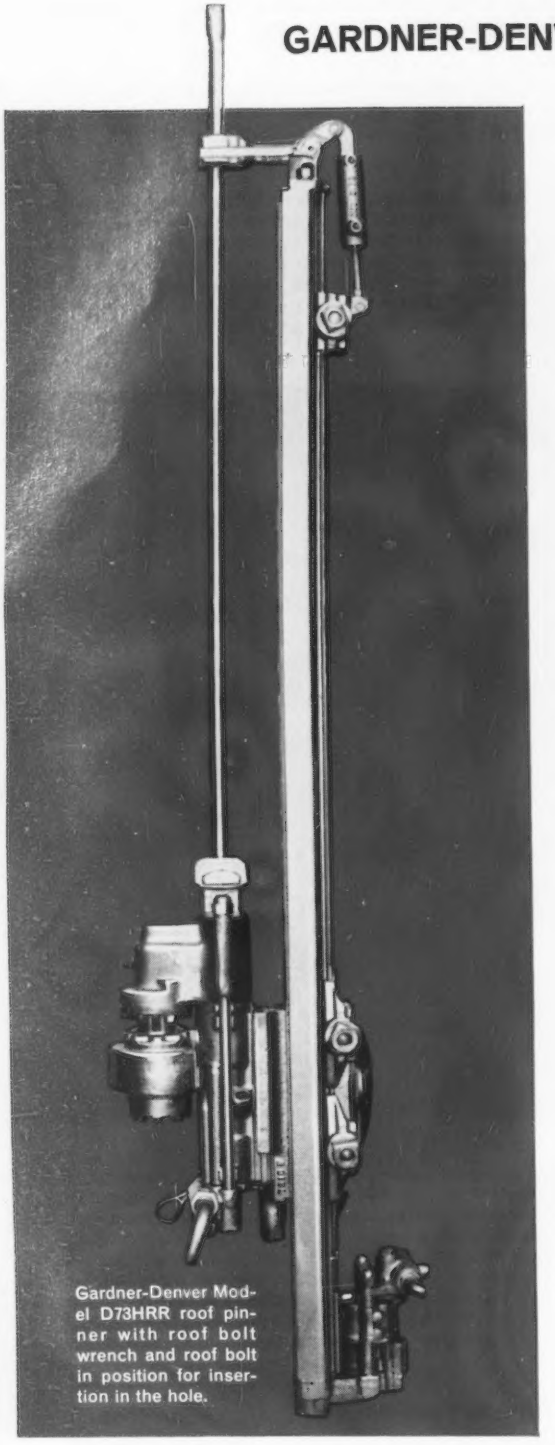


Reliable performance that's one mile high: This A-C substation has completed about five years' service 6546 feet up the remote Wasatch mountains of eastern Utah. Equipment survived rugged transportation up the mountain side on steel skids or trucks over rough bulldozed road. One switchgear fell from truck but was not damaged beyond a few dents. Picked to give dependable performance in this inaccessible, practically unserviceable location, A-C substation has proved out well beyond expected performance.

ALLIS-CHALMERS PRODUCTS: Look to Allis-Chalmers for compressors, controls, crushers, earth-moving equipment, electrical distribution equipment, engines, generators, industrial systems, kilns, lift trucks, mills, motors, pumps, rectifiers, screens; thermal, hydro and atomic electrical generating equipment; tractors, transformers, unit substations.

ALLIS-CHALMERS

GARDNER-DENVER MAKES THE NEWS



Gardner-Denver Model D73HRR roof pinner with roof bolt wrench and roof bolt in position for insertion in the hole.

New roof pinner does all 3

1 DRILLS THE HOLE
2 INSERTS THE BOLT
3 TIGHTENS THE NUT

This Gardner-Denver roof pinner does the complete roof bolting job. It's Model D73HRR—your easiest step to simpler, quicker roof pinning.

Ask your Gardner-Denver Mining Specialist for a demonstration. See how the D73HRR remote-control pneumatic centralizer spots hole quickly, keeps the steel in line with the drill. Check all the features:

Powerful, trouble-free hydraulic motor—provides the required rotation speed for drilling in different types of rock.

Remote-control operation—of all functions of the drill, rotation motor, feed motor and centralizer.

Adjustable feed mounting—gives proper thrust when drilling, maximum speed when retracting steel or inserting bolt.

Pneumatic centralizer remote-controlled—provides excellent support for accurate hole spotting.

Protective roof bolt wrench—guards against hammer impact on the roof bolt if hammer is accidentally turned on during the nut-running cycle.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

Gardner-Denver Company, Quincy, Ill.—Offices in principal U.S., Canadian and Mexican cities
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario.

International: Gardner-Denver International Division, 233 Broadway, New York 7, N. Y.
Offices: Buenos Aires, Argentina; Artarmon, N.S.W. Australia; Brussels, Belgium; Rio de Janeiro, Brazil; Santiago, Chile; Barranquilla, Colombia; Lima, Peru; Ndola, N. Rhodesia; Salisbury, S. Rhodesia; Johannesburg, Transvaal

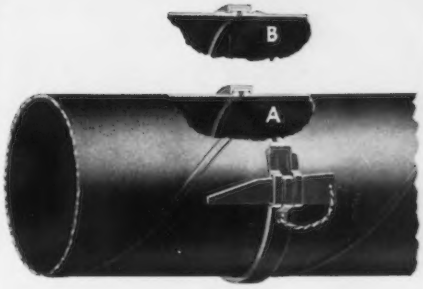
You're SAFE Underground With This NAYLOR Combination

You can't beat the combination of NAYLOR Spiral-weld pipe and Wedgelock couplings for providing fresh air and getting rid of gases and fumes in underground operations.

This light-wall pipe has built-in extra collapse strength and safety for push-pull ventilation. It's easy to handle—easy to install. And you save more valuable time when you use Wedgelock couplings. These easy-to-use connections enable you to couple joints with only one side of the pipe in the open. Lines hug the wall and can be extended quickly as work progresses.

It will pay you to get the details on this time-and-money-saving combination for air, water, tailings or ventilating service.

Ask for Bulletin No. 59



The NAYLOR Low-Pressure Wedgelock coupling for ventilating service can be furnished for pipe with (A) accurately-sized shoulder ends or (B) with grooved ends. A hammer is the only tool needed to connect or disconnect this coupling.

NAYLOR PIPE *Company*

1243 East 92nd Street, Chicago 19, Illinois

Eastern U. S. and Foreign Sales Office: 60 East 42nd Street, New York 17, N. Y.

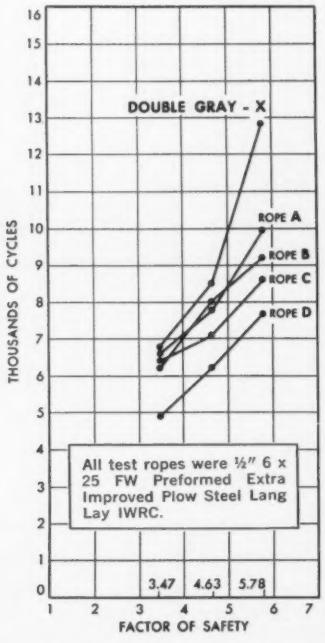
CF&I Steel Products... a tradition in the mining industry

Experienced, cost-conscious mining men usually insist on long-lasting, top performing supplies, rather than looking for "bargains." They know that initial cost is frequently the least important part of their investment. That's why so many mining engineers now turn to CF&I for dependable steel products—products like the ones shown on these pages.

These truly economical "mining tools" are made here in the U.S.A. to above-industry standards. Each has the maximum degree of quality built into it, and is backed by the entire resources of CF&I—your guarantee of real value.

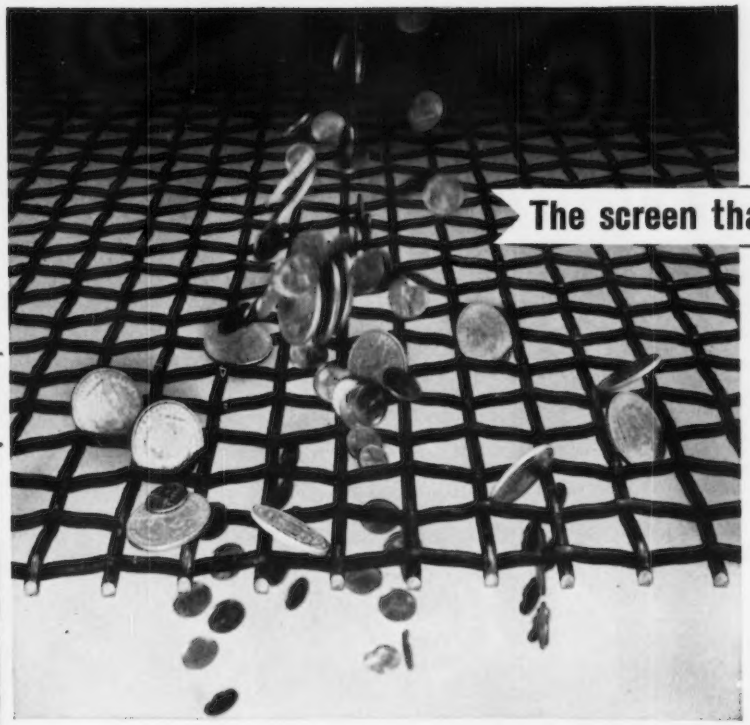
Get the complete money-saving story on CF&I Steel Products for Mining from any CF&I sales-engineer. He'll be glad to sit down with you and review your requirements.

The rope that lasts longer



CF&I-Wickwire's new wire rope—Double Gray®-X—lasts longer than other wire ropes. In an extended series of tests at CF&I's Palmer Plant, five competitive high strength wire ropes—all made by major manufacturers—were tested to destruction on a 25,000-lb. fatigue-testing machine. Double Gray-X lasted longer than the other four ropes at all three safety factors used—45%* longer at the highest and most commonly-used safety factor. Because it lasts longer on even the toughest jobs, Double Gray-X lowers your wire rope investment and drastically reduces costly equipment downtime.

***Percentage above average of all other wire ropes tested at safety factor of 5.78.**



The screen that never passes the buck

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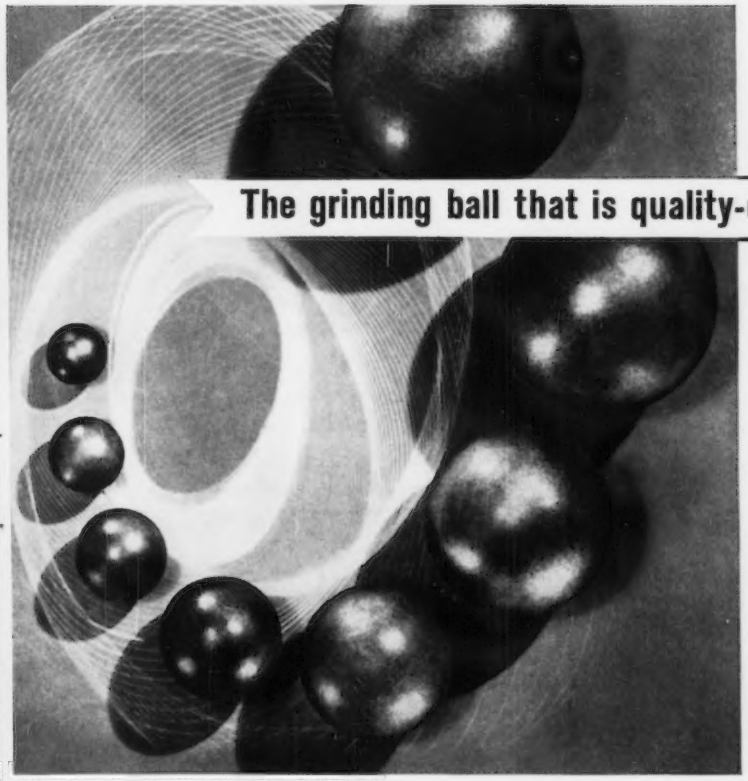

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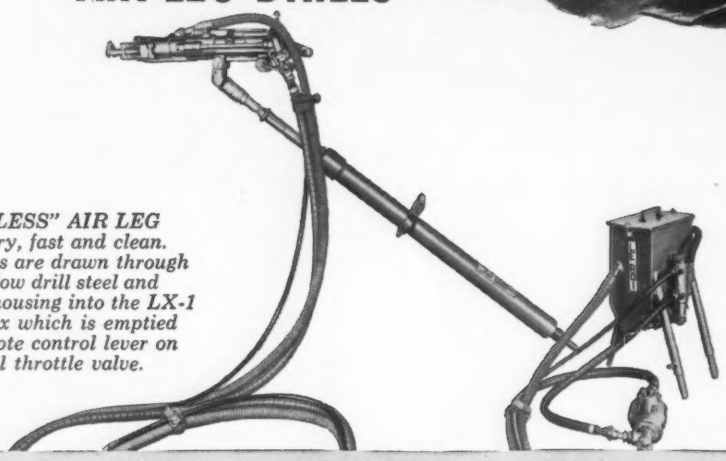

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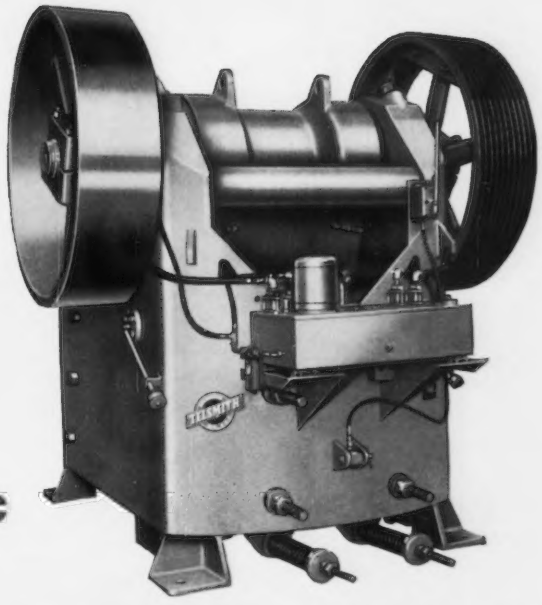

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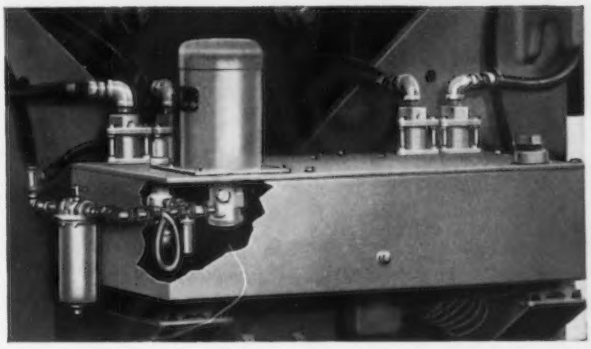

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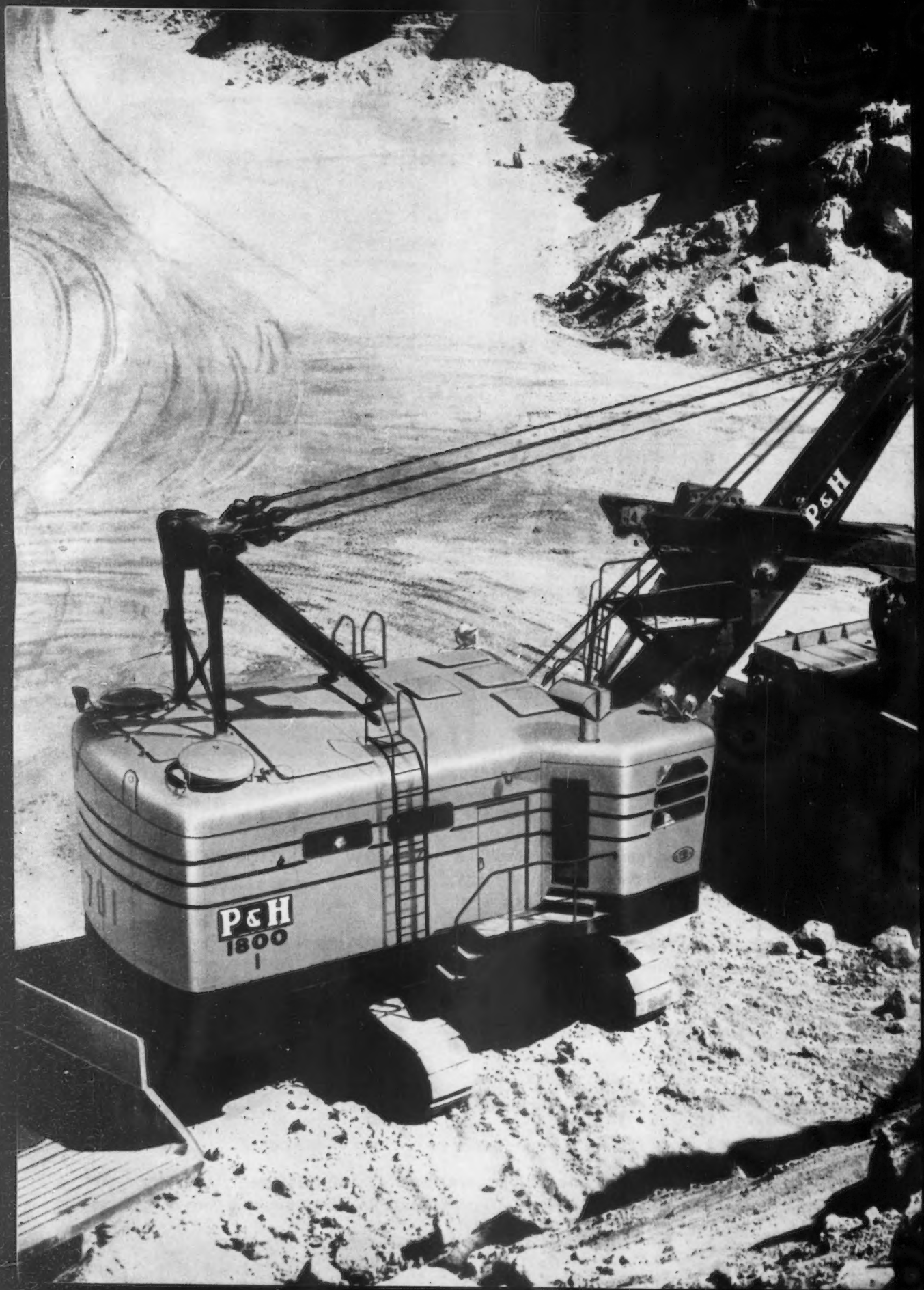
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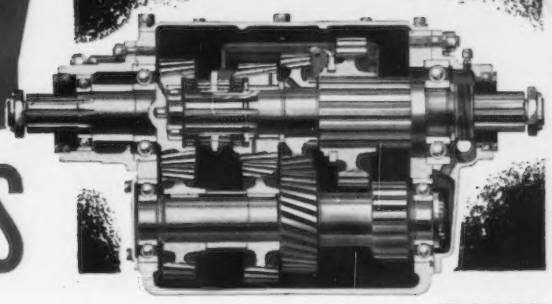

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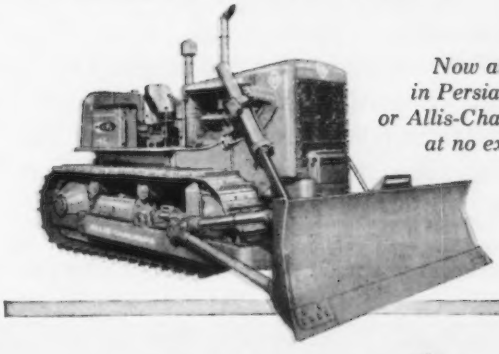

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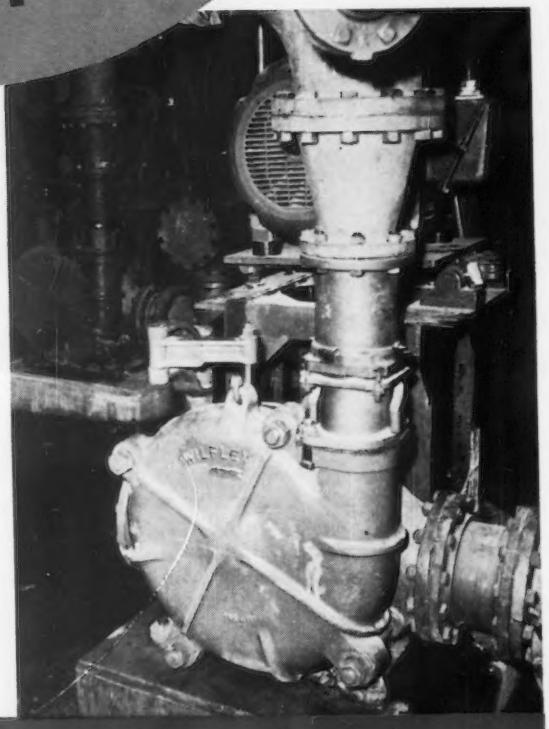

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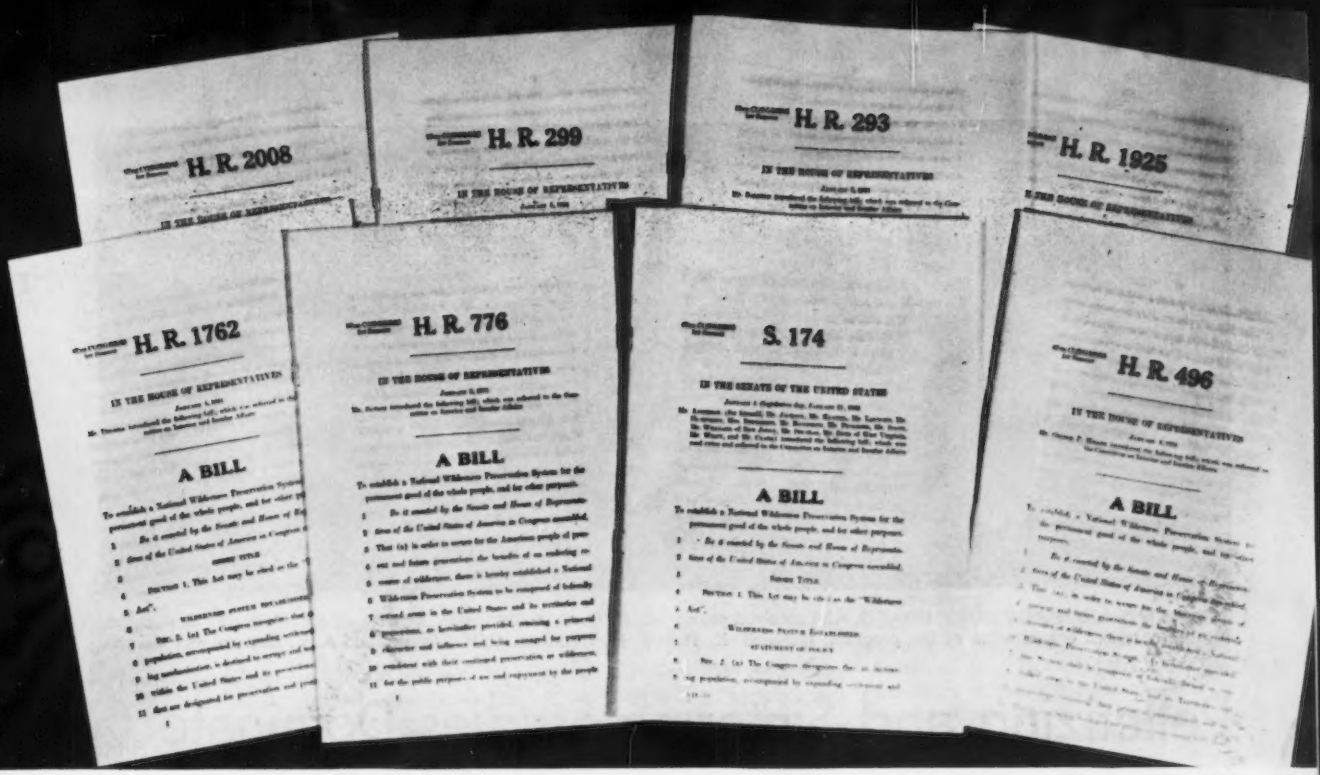


WILDERNESS BILLS, now before the 87th Congress, propose more hurdles for mining.

If We Had a Secretary of Mines . . .

. . . . WE MIGHT EXPECT to have a champion in Washington who would be authorized by law to look after the constructive interests of the mining industry in much the same manner as the Secretaries of Agriculture and Labor function in behalf of their respective groups.

Repeating the subject of our April editorial, we urge citizens of states with mineral resources, the mining industry and regional and national mining organizations to support a bill which will establish a separate Department of Mineral Resources with a Secretary of Cabinet status (See E&MJ April p. 19.) to thwart attacks which are being made on mining (perhaps entirely unintentional) by an uniformed Administration, Congress and public.

As a case in point, let's consider the flood of bills to preserve the national wilderness areas now pending in Congress. These bills in effect would sterilize vast areas from public or private occupation prohibiting "commercial enterprises, permanent roads, the use of motor vehicles, motorized equipment, or motorboats, or landing of aircraft or any other mechanical transport or delivery of persons or supplies, or any temporary road, etc." In short more Government land would be withdrawn from the shrinking areas now open to prospecting and mining.

To be fair, it should be noted that bills such as S. 174 and H.R. 1925 provide that the President may authorize prospecting and mining in specific areas "as he may deem desirable." But why the people or the Congress of the U.S. should want to surrender the responsibility of discretion solely to the President and not retain this power in the legislative bodies is beyond all comprehension.

There is a good chance that so-called wilderness legislation may be passed because it appeals to the public—the uninformed public which wants nature preserved for future generations and which still considers mining an exploiter and despoiler of public lands. Actually of the 3,608,787 sq miles in the U.S., including the new state of Alaska, less than 1,000 sq miles are occupied by mines which have produced gold, silver, copper, lead and zinc during the past 50 years. If you travel by plane you have to look sharply and fast to see any land occupied by mines. But the public doesn't know or accept this fact, hence the danger that wilderness legislation may pass.

Now if we had a Secretary of Mineral Resources, it would be quite probable that wilderness bills as now drawn would never get beyond the introductory stage in Congress. Secondly, if such bills were passed, a Secretary of Mines, with occasional access to the ear of the President, would be in a position to recommend action which would promote domestic mining and prospecting.

If we had a Secretary of Mineral Resources, perhaps it wouldn't be necessary for mining men to plead for and defend the right to search for and develop mineral resources on public domain before a board of Government agencies (Forest Service and Bureau of Land Management), as they have done recently at wilderness hearings in Idaho.

The need for better mining representation in Washington is critical at this time because there is a growing antagonism toward mineral development by U.S. venture capital in many parts of the world. Secondly, since our industrial strength is largely dependent upon consumption of a substantial portion of the world's mineral output, it's not too early to be thinking about extracting copper, nickel, cobalt and phosphate from vast underwater nodule deposits; aluminum, potash and other materials from syenite, clays or even granite; iron from semi-taconites; and oil from oil shales. We need to see beyond the current temporary surfeit of metals and minerals, and develop mineral resources as never before to meet the needs of an exploding population with expanding per-capita requirements. For all this we need a man and a department in Washington for development of mineral resources.

THE SYMPOSIUM ADVISORY BOARD, who received praise for the excellent organization of the program, included: K. H. Roll, T. B. Counselman, general chairman W. B. Stephenson, F. M. Hamilton, C. F. Clausen, and A. Y. Bethune (not shown).

Pelletizing and Sintering Studies Dominate First International Agglomeration Symposium

AT ONE of the best organized and most efficiently run meetings in the history of the mining associations of the U.S., 595 industry leaders attended the first International Symposium on Agglomeration in Philadelphia in mid-April.

Beyond the highlights of the various papers described below, the symposium consistently emphasized three dominant points:

1) Careful and complete pre-mixing of materials in front of the sintering machine or pelletizer is vital to improved production.

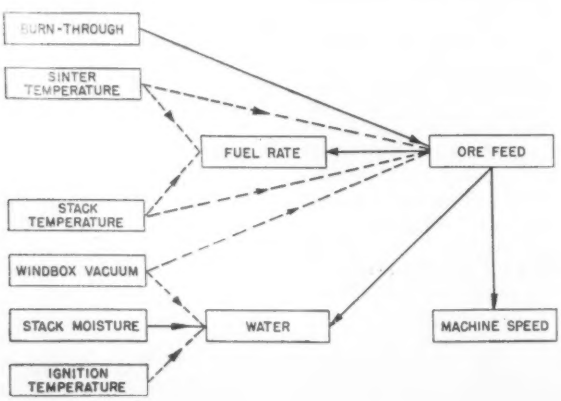
2) Updraft furnaces seem most effective for lead-zinc treatment, and for many iron ores as well, though one speaker flatly spoke out for updraft on Pb-Zn, downdraft for iron ore.

3) A subject that provoked vigorous comment at many points was the lack of uniformity in quality-testing of agglomerated products. There are so many different tests, each used by its own proponents, that it is hard to compare different sintered products from different operations because of different specifications used in testing them.

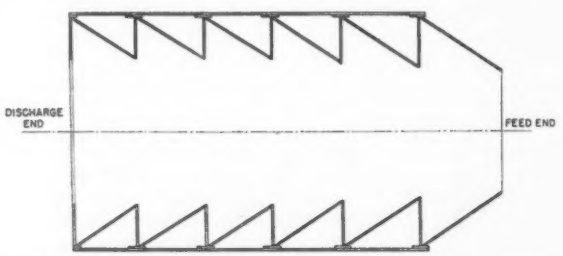
One concrete result of the symposium was that a group of men interested in standardization of quality-testing got together at one of the luncheons and proposed a system for making a start toward standardization. M. Jacques Astier of IRSID in Paris agreed to serve as coordinator. Metallurgists will send him descriptions of their test methods and specifications. He, together with his associates, will compile these, study the differences, and try to come up with some recommendations toward standardization. Such recommendations might be the subject of a paper to be given at next year's AIME blast furnace, coke oven and raw materials conference.

In the only dual session, five papers in one assembly room were devoted to sintering as applied to powder metallurgy, while in an adjacent room the general subject of the five papers delivered was engineering and design of commercial sintering plants.

As a tribute to the excellent planning of chairman W. B. Stephenson of Allen-Sherman-Hoff Pump Co. and his committee, all sessions were well attended and participation in discussions after the presentations by the various authors was enthusiastic



HOW sinter plant might be automated: monitor 6 variables, left; error signals control operating rates, right & center.



MULTIPLE-CONE DRUM PELLETIZER gives high retention time, rolling & compressing action, & particle contact. (Stirling)

THE HOSPITALITY of the Grace Mine at Morgantown, Pa., was enjoyed by more than 100 registrants at the Agglomeration Symposium on the fourth day of the session. The 5800-tpd pellet capacity plant, with its mine and headframe, is designed to fit into the surrounding landscape and typify the mine's role as a good neighbor.

and refreshingly pointed. An observer could not fail to believe that the symposium succeeded in its purpose of exchanging information from "industry to industry, from one geographic area to another, from research laboratories to production and engineering."

Of the 36 papers presented, half were by authors from Sweden, England, Australia, Brazil, West Germany, Scotland, Japan and Canada.

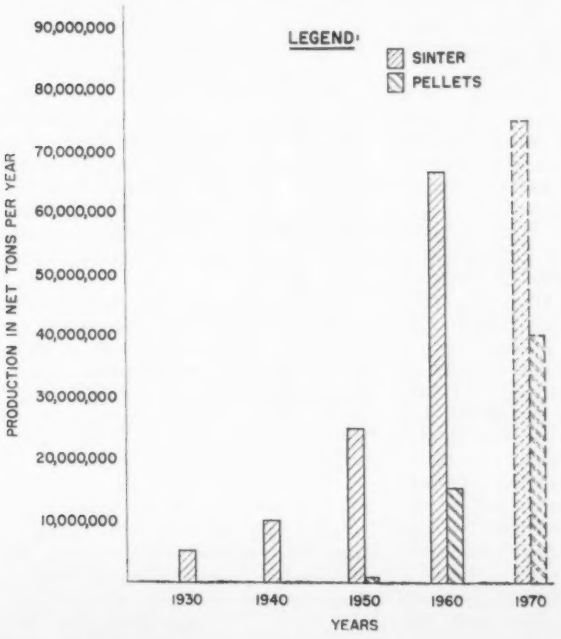
The first day's welcoming luncheon heard Ronald R. McNaughton of Trail, president of AIME. Subsequent luncheons were distinguished by another inventive stroke of symposium planning: various tables at the informal gatherings were assigned to the respective authors. Thus, if a registrant had further questions for an author, and had not been able to ask them in the meeting proper, he could join the author at his table and continue the discussion.

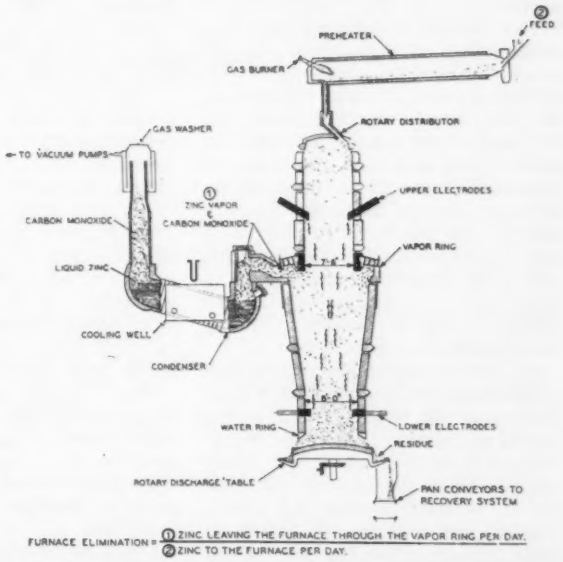
In the regular proceedings, the AIME followed the European practice of letting the various authors give basic summaries of their papers, to leave greater time for discussion. Since all pre-registrants had received copies of the complete papers weeks before the symposium, there was no time lost in lengthy narration.

Don E. Warnes, of St. Joseph Lead Co.'s Monaca, Pa. works, discussed the relationship between measured properties of zinc oxide sinter and some performance characteristics of the electrothermic zinc furnace. His group found that zinc elimination from the furnace charge increased 2.99% for each 0.10 unit decrease in sinter hardness within the sinter hardness range from 0.449 to 0.254 units, hardness being measured by a tumbler test method.

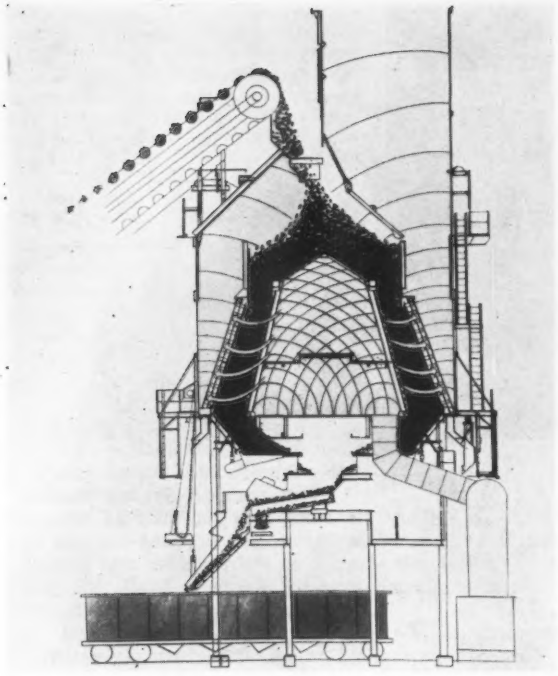
Concurrent to the study of sinter-hardness-zinc elimination relationship, the St. Joe study tabulated chemical composition and hardness. It found that increases of zinc and magnesia reduced hardness, and that increases of iron, silica and lime also increased hardness. While the group noted other variables that might affect hardness, Warnes emphasized that more than 60% of the sinter strength variation is accounted for by composition factors.

In the discussion following the Warnes paper, R. M. Sellwood, of Imperial Smelting Corp., Ltd., Avonmouth, England, underlined the Warnes comment on chemical composition influencing hardness, and a speaker from New Jersey Zinc Co. questioned the strength of the magnesia influence. Mr. Warnes agreed on the point that zinc content, which has the most marked effect, should





ST. JOE'S zinc furnace was outlined by D. E. Warnes. Arthur G. McKee speakers compared the future of sinter vs pellets.



D. D. Phelps, supplementing his and J. A. Anthes' paper on factors controlling the cooling rate of sinter, described the stationary cross-blown sinter cooler developed by Dravo Corp.

The cooler operates very simply. A pan conveyor feeds hot sinter into its top. Sinter flows by gravity through the cooler proper, then is discharged at the bottom by vibrating feeders located radially around the bottom. The discharged product can be screened, by a vibrating screen, or it can be discharged directly to railroad cars or to a conveyor.

Ordinary-temperature air is blown into the central plenum chamber by a forced-draft blower, located at lower right in drawing. It passes by several openings through the bed of descending sinter, to the outer plenum chamber, and eventually up the stack. Because the outer chamber is big, air velocity in it drops, and dust particles settle out. Only for a few materials is separate dust-collecting necessary.

The long retention time of large lumps, up to 1½ hr, solves the problem of cooling the lumps. Smaller particles, which require less cooling time, move through faster. The gentle motion of solids through the bed frees trapped dust, allowing it to move out into the outer plenum chamber with the air stream; this makes for a clean discharged product. Operation of the cooler can be automatically controlled, and an operator is not necessary.

The cooler has already been installed in at least one iron-ore sinter operation (at J&L Steel's New York Ore Div.—see E&MJ February 1961 p154); and coolers are being designed for other applications, such as cooling nodules, pellets and cement clinker.

also be given emphasis in listing factors which reduced hardness.

Harold T. Stirling, of Koppers Co.'s agglomeration laboratory in Pittsburgh, discussed recent advances in balling and pelletizing, and introduced the multiple-cone balling drum, developed at Koppers. The new drum provides a high retention time within a short length and was used successfully to ball flyash and grindings from plate-glass factories (for lightweight aggregate) using 20% water and no binder. Stirling told the audience that sized pellets of good green strength can be made from a relatively coarse-grained specular hematite concentrate, and that large magnetite pellets can be made from fine concentrate by adding feed and fines alternately in successive bays of the machine. In both hematite and magnetite, fines are returned to the front of the drum and, in the former case, slightly undersize balls would be returned to a point near the discharge end. He also indicated that a shorter sintering strand might be needed.

Mr. Stirling was able to report some commercial results of the drum's work which had not been available at the time of publication of the paper's preprint. A 17-cone machine (see drawing), 12x40 ft, produced at 4700 tpd with a retention time of plus 3-min. With 20 tons capacity, the first three cones served as mixers, two served returns, and 12 cones handled actual retention.

The commercial plant dropped the rpm of the drum from 8 to 5 and found the percent of plus-⅛-in. size increasing, until at 4 rpm there were no fines left. With that product entering the sintering machine, the production rate rose 11%, and 15% less grate area was used.

J. E. Moore and D. H. Marlin of Dravo Corp. reported the results of tests of hot-briquetting of partially-reduced iron oxides. They found that the more reduced the oxide was, from hematite through magnetite through wustite, the softer and more malleable it was, and hence the more suitable for self-binding in a briquette.

The variety of materials tested ranged in scope from flue dusts through jaspers to Labrador specular hematites, and in size from predominantly minus-325-mesh up through ¼-in. Briquetting temperatures up to 1500°F were used, and briquette strength improved with increasing temperatures, with degree of reduction of oxides, and with briquetting pressure. Lower-oxides and metallic iron in effect formed a welding medium which held the briquette together.

The authors claimed that hot-formed briquettes, in comparison with other forms of agglomerates, showed superior or comparable qualities in the factors of reducibility, high-temperature strength, resistance to degradation, and permeability of bed for passage of reducing gases in the reduction furnace.

A long paper by D. M. Urich and Tsu-Ming Han, of Cleveland-Cliffs Iron Co.'s Ishpeming laboratory, reported results to date in a testing program aimed at raising the quality of specular hematite pellets.

Three factors were studied: Grind (thus, particle size); induration temperature and size of pellet. The aim was to produce the strongest possible pellet that would withstand compression and abrasion both in handling and shipping and in the blast furnace shaft.

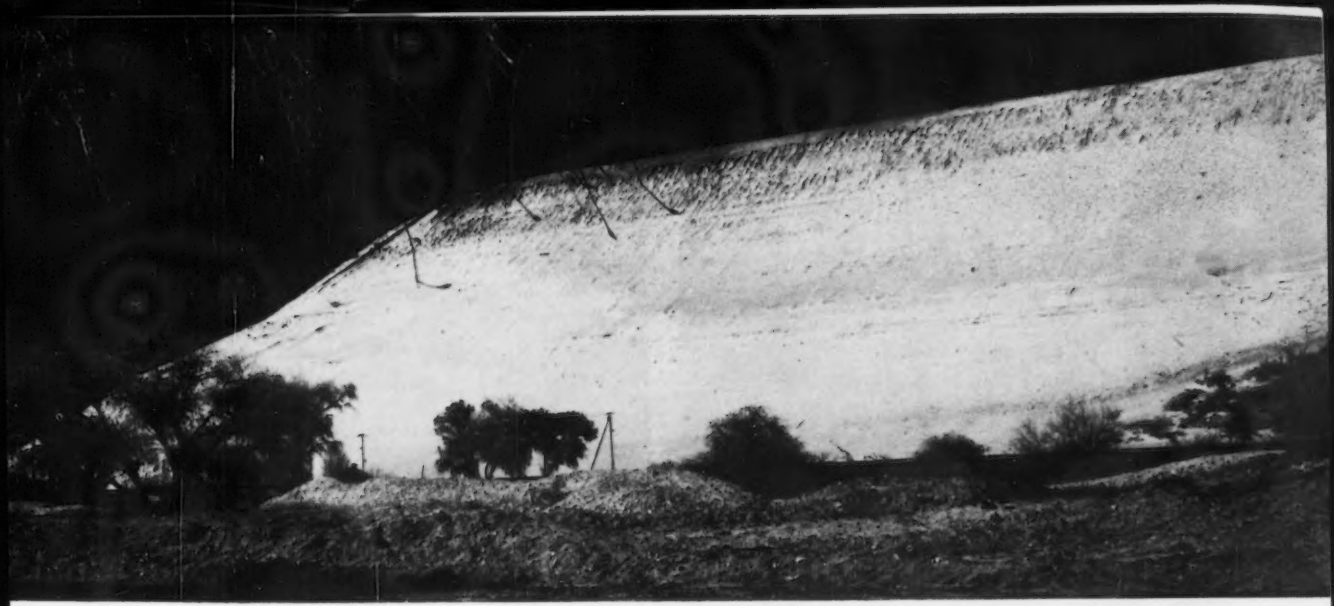
Grind was found to be the greatest contributing factor to pellet strength. The finer the grind, the greater the pellet strength; with 100% minus-325-mesh producing the best results of all.

The best temperature of induration appeared to be in the range 2450-2500°F. Bulk density and porosity of a pellet could be controlled within limits through controlling grind and temperature. The factor of pellet size was least important, though larger pellets have greater compressive strengths than smaller ones.

Urich and Han's pellet-strength tests were conducted at high temperatures in a Lindberg furnace, as well as at ordinary temperatures. Their test conditions covered grinds from 45 to 100% minus-325-mesh, temperatures from 2400 to 2550°F, and pellet sizes from ¼- to ¾-in.-dia.

P. A. Young and D. A. Barnard, of Head Wrightson & Co. Ltd., London, England, discussed "The Cooling of Sinter" in a paper that started with a theoretical discussion of the cooling

(Continued on p 144)



AN EXAMPLE of the kind of long-term stability which is possible through careful planning of tails disposal is the bank at Miami, Ariz., which has been out of service more than 30 years but remains strong at a height of 200 ft.

SPECIAL REPORT

How the Soils Engineer Can Help the Mill Man In the Construction of Proper Tailings Dams

BRUCE N. MAC IVER

AS THE MODERN MINE improves its extraction efficiency and, through the use of new equipment and techniques, attacks lower and lower-grade orebodies, it also intensifies one of the major headaches of the mill man: the disposal of tailings and the maintenance of dams.

The quantity of tailings is growing greater, so the dams must be higher. But particle size is smaller, so the material is less and less satisfactory as dam building material. Add the frequent need for segregating certain piles for future retreatment and lo, the poor mill superintendent!

Annually, the mining industry must dispose of millions of tons of fine tailings from the mill. When the tails are impounded hydraulically on the surface the resulting embankments can reach to heights that rival the mightiest of earth dams, and exceed many in material contained. But, while earth dam engineering is founded on a body of fully published theory and practice, tailings dam construction receives little discussion in mineral dressing literature.

Mr. MacIver is a soils engineer with International Engineering Co., Inc. of San Francisco. Many of the data presented were obtained by that firm in studies of Kennecott Copper Corp.'s Utah Copper Div. and Ray Mines Div. construction of tailings dams.

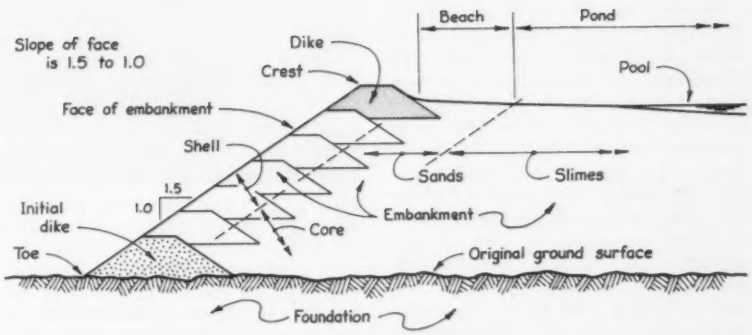
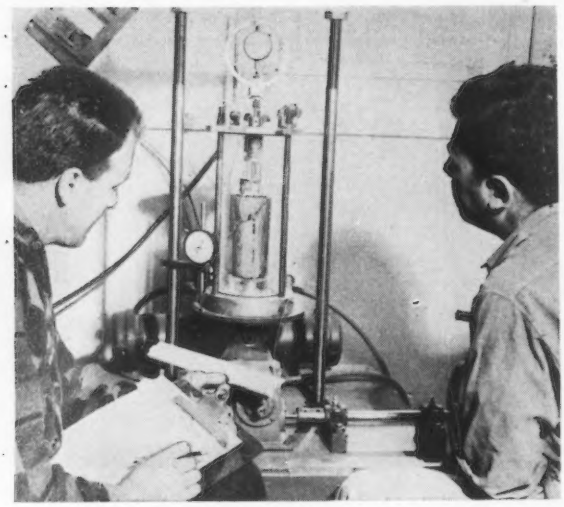


FIG. 1 Nomenclature for an idealized disposal area describes the section.

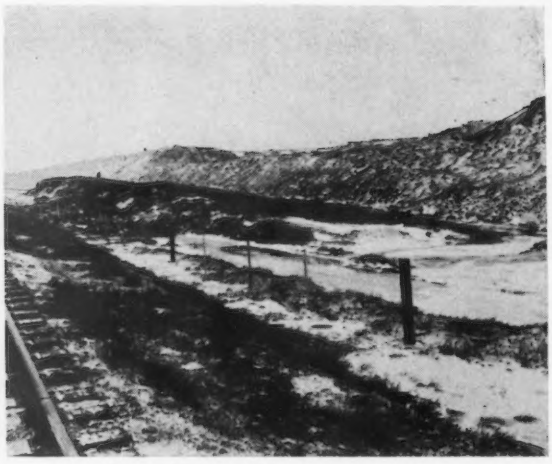
The mill operator, then, has generally either suffered occasional failures because of improper construction or avoided them by ultra-conservative practices. Both unsafe and over-safe practices are costly, and might well be reduced by more careful application of the principles of soil mechanics and earthwork engineering.

Like many other established practices in the mining industry, tailings dam construction and placement has "just growed." In the earliest operations in the American West, the mine and the mill superintendent could simply take advantage of the usually remote, barren and arid region near the property and deposit tails in streams or out upon large idle tracts of land. Where tailings were impounded, possibly to recover scarce water, there was almost an unlimited choice of low-value sites in canyons or arroyos.

The standard construction method of such dams (Fig. 1 suggests the nomenclature) was to pond the waste from a pipeline or launder along the crest of an earthen dike across a canyon; if no canyon were available, the dike and discharge line would enclose two or more sides of the area. As the discharge flowed from the perimeter toward the center of the pond, the



TEST APPARATUS is used to find triaxial compression. Water in the chamber provides confining pressure.



SHEARING FAILURE along a cylindrical surface (see text) took place at the Garfield pond in February 1942. Lifting of the ground in front of the toe and crest subsidence are typical.

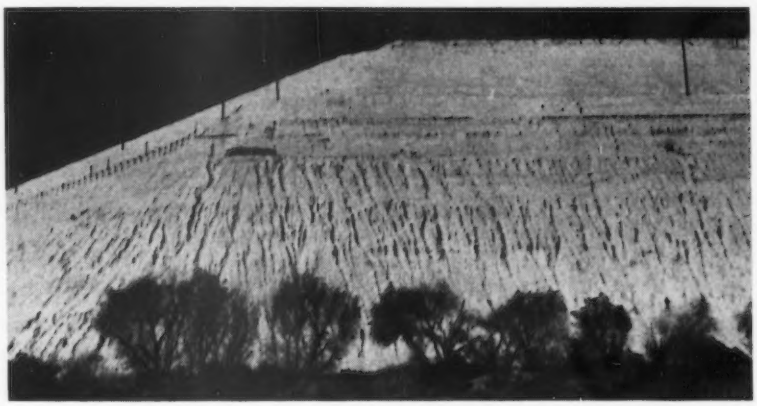
coarser fraction would be deposited closely behind the dike while the fines and slimes were carried out into the pond. Clarified water was decanted from the pond after settling. When deposits rose to the crest of the earth dike, a new dike would be placed atop the original and the steep slope continued.

In those "good old days" should tailings be allowed to pollute a body of water, there were neither laws nor other interests to raise an objection. Even a major failure of an embankment might not be serious, since there was usually ample space to receive the flow, and a failure could be "corrected" by starting a new dam at another site. The success of the earlier dams was further aided by the relative coarseness of the tails and the low percentage of solids in the mill effluent, both providing good hydraulic separation of the coarse and fine fractions.

The New Need

Today, the picture is different. Land, though in the remotest location, is not free, and houses and highways now surround the disposal areas. The sites remaining for disposal may be quite distant from the mill, and have a topography which is unsatisfactory for the more common impounding techniques. Although water is relatively more available than in the early days of the West, it is costly, and Governmental controls over surface waters preclude the possible contamination of a river or a lake. Today's factors all contribute to the rising cost of tailings disposal and a demand for safer, but more costly, dams.

Handling costs grow with the need to move greater quantities of material,



THE EXTERIOR SHELL or "skin" of the tailings dam has a relatively uniform shearing resistance, primarily due to the absence of excess pore pressures in the zone.

with higher specific gravities, over longer and longer distances. For, as the urgency of water reclamation has grown, the sp gr of the pulp which is discharged into the pond is raised by thickeners and cyclones. Thus, pumping and piping are more difficult and the separation of sands and slimes is made more complex.

In addition, there is the hazard of dam failure because of too-great height of modern ponds. Some, in fact, are attaining heights which peril their very stability. And, some such embankments stand high over permanent communities, highways, rivers, and the mills themselves.

To what extent can the soils engineer help the mill operator?

Soil Mechanics Fundamentals

With the problem now roughly outlined, consider next the tools with which the soils engineer might help in the solution. Soil mechanics is the relatively recent (1925) offspring of a marriage between civil engineering and engineering geology, and is thoroughly infused with theoretical hydraulics and mechanics. The object of its interest is not the "soil" which supports plant life, but what the geologist calls "regolith" or unconsolidated rock in general. Since soil, either of natural or artificial deposition, possesses a complex solid-liquid-gas structure, soil mechanics seeks to measure its physical properties, determine the stress distributions in both the solid and liquid phases (air pressure in the soil voids may usually be neglected), and to predict the strength and deformation of the soil structure under load changes.

The most important principle in soil mechanics is based on the concept of *effective stress* in the soil-water system. If the void space (or pores) in a deposit of sand were completely filled

with water under hydrostatic pressure, each particle of sand would press against its neighbor with only the buoyant weight of the overlying particles. Therefore, frictional resistance between the grains will be mobilized by just the *effective stress* which is equal to the difference between the *total stress* (produced by the dry weight of particles) and the *pore water pressure*. Should this pore pressure become greater than hydrostatic, the particles might become completely buoyant and the deposit would have no frictional strength, as in a quicksand.

Soils composed of, or containing, very fine and plate-shaped particles (clay) exhibit a more complex behavior since the low permeability of the mass introduces a time factor. If a fully saturated clay were subjected to an external load, the immobility of the pore water would result in a portion of the load being supported by an increase in the pore water pressure and not all of this added load would contribute to the strength-mobilizing effective stress. Only with the passage of time (sometimes months or years) will the excess pore pressure be transferred, accompanying a volume change, to the intergranular contacts. This stress-deformation adjustment is termed "consolidation" in soil mechanics and, therefore, has a more restricted meaning than in geology. A fine-grained soil further complicates the picture because electro-chemical bonds exist between the plate-like particles and provide a strength, or "cohesion," which is somewhat independent of effective stress. Duration and rate of loading, degree of saturation, mineralogical composition of the clay particles, and even impurities in the pore water can confuse this effective stress principle.

The following simplified example may illustrate the utility of the principle. To determine the shearing resistance of an embankment, several undisturbed samples of the material are secured and each is subjected to a confined (or "triaxial") compression test in the laboratory. The pore pressure within each specimen is measured during the test and subtracted from the *total confining pressure* to obtain the *effective stress*. Several triaxial tests, at different confining pressures, are correlated by the Mohr failure criterion to produce a "strength envelope" (Fig. 2) that expresses the inherent *shear strength* (not shearing resistance) of the soil as a function of the effective stress. At any given point within the embankment, the *total confining pressure* can be computed from the weight of overburden, and a piezometer installed at that point is used to measure the pore pressure. The difference between these two values is the effective stress which allows the shear strength at the point to be found on the laboratory strength envelope. Then, the summation of shear strengths along a potential failure surface gives the shearing resistance.

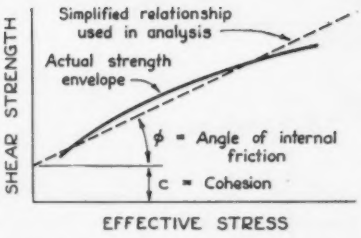


FIG. 2 Triaxial compression tests gave results such as these.

The second tool available is not a principle, but rather an understanding of the seepage of water through soils or, in particular, through earth embankments. The pattern of pressures and velocities in the seeping water will be uniquely related to the geometry of the embankment, the variations in permeability, and the hydraulic gradient. Not only will this flow pattern influence the effective stresses, and, thereby, the shearing resistance of the embankment, but it also controls the formation of "pipes" in the structure. Were a substantial drop in the hydraulic gradient to occur at the exterior face of an embankment, the pressure acting on particles in the very surface might lift and move these particles off the face and, in a continuing process, create a hole in the surface. As the hole, or pipe, works back into the embankment, the hydraulic gradient is increased at the rear of the hole and the piping accelerates. A piping, or "washout", failure results when undermining causes a collapse, or when the pipe reaches the pond and then rapidly enlarges as the water rushes through. Nothing demands greater attention from the earth dam engineer than this insidious menace.

Analysis of Stability

Theoretical soil mechanics combined with empirical earthwork engineering yields several methods for applying a factor of safety to the stability of an embankment. A shear failure of the embankment can be analyzed by assuming that a mass of material will tend to slide along a cylindrical surface, downward and outward, as shown in Fig. 3. The weight of the mass is resolved into components tangential and normal to the failure surface, with the tangential component providing the *actuating force* while the normal component mobilizes the *shearing resistance*. The factor of safety is then computed as the ratio of the resisting force to the actuating force (F=R/T).

If the embankment contains a horizontal stratum of low shearing resistance, the failure surface may be distorted from an arc and follow the weak stratum. This mode of failure, as shown in Fig. 4, may be analyzed by computing the lateral earth pressure, caused by the weight of an "active" wedge, against the vertical end of a "passive" block of material. The tendency of the passive block to slide out from the embankment will be countered by the shearing resistance through the weak stratum that can be mobilized by the weight of the block. As before, the factor of safety is the

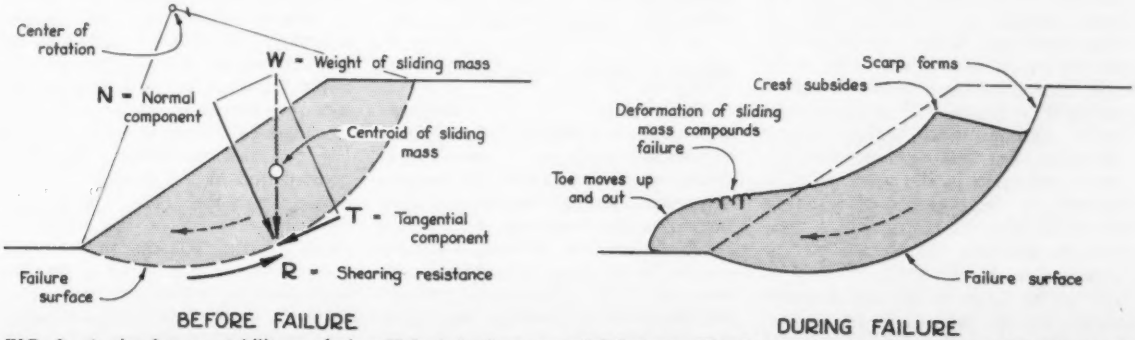


FIG. 3 A circular-arc stability analysis will include these essential features. The factor of safety here is computed F = R/T.

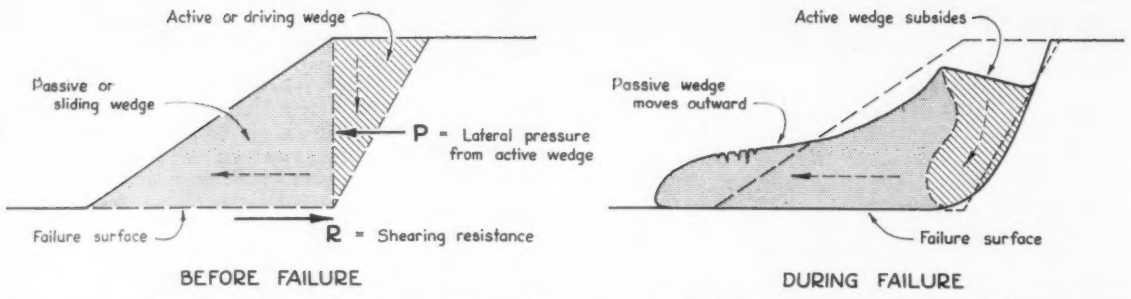
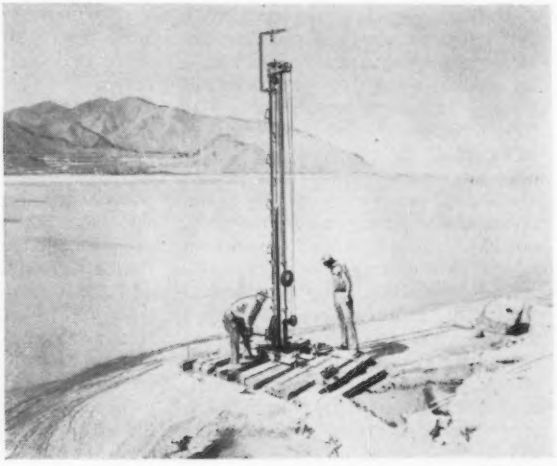


FIG. 4 Essential features of a sliding-wedge stability analysis. A horizontal stratum of low shearing resistance will distort.

LIQUEFACTION was the chief cause of the above failure at Garfield in October 1941. Minor shearing may have begun it.



SOILS ENGINEERS may use undisturbed samples from the edge of a dam like Kennecott's Garfield, Utah for study bases.

ratio of the resisting force to the driving force (F=R/P).

Either of these methods require a cut-and-try approach with many trial failure surfaces being analyzed; the surface yielding the lowest factor of safety is the critical surface along which a failure would most likely occur.

Earthquakes can be considered in stability analyses by using a static force based on an assumed horizontal acceleration equal to a percentage of the acceleration produced by gravity. However, it is not possible to quantitatively analyze the effect of an earthquake shock on a loosely-packed, cohesionless material of the type deposited near the face of a hydraulic-fill dam. When a dynamic load, caused by an earthquake or by blasting, is applied to a loose, saturated sand, the particles will be induced to settle into a more stable, denser structure. But this tendency, requiring a reduction in the void space, is resisted by the presence of water in the voids and the intergranular pressure is suddenly transferred to the pore water. If the mass of sand is sufficiently large to prevent a rapid dissipation of this excess pore pressure, the sand may lose its frictional strength and will become "liquefied," as in a quicksand. Liquefaction has caused the failure of many hydraulic-fill dams, with material flowing like water for hundreds of feet, and it must be emphasized that an embankment of tailings deposited by perimeter discharging is identical to a hydraulic-fill dam.

These few, interrelated notions illustrate the association of theory and practice that has been so valuable in earth dam engineering. The principles are proven by years of experience and their limitations, as well as their potentials, are recognized by all. Sadly, a general application of soil mechanics principles to embankments of mill tailings is long overdue.

Existing Embankments

The attention of the soils engineer is naturally first drawn to the gigantic embankments of tailings now in existence sprawling in canyons or upon easy slopes. Rising ever upward, their faces at slopes sometimes steeper than 1.5 (horizontal) to 1.0 (vertical), these embankments must provoke many questions in the mill operator's mind: Will there be a point at which the very height of this monster will tend to bring it down? What is this maximum permissible height? And, if the limit were reached, must this disposal area then be abondoned? How much should the slope of the face be reduced to continue both growth and safety?

Of course, it is possible to give answers to these questions by the analytical methods of soil mechanics, but any factor of safety found for the stability is no more valid than the accuracy with which the shearing resistance of the embankment is known. This shearing resistance can be difficult or impossible to determine in many cases.

For some distance into the face of a tailings embankment, the material is usually a mixture of "naturally" deposited tailings and "artificially" remolded tailings or earth used in the dike construction. The variation in thickness of this shell can be seen in Fig. 5, which represents a partial reconstruction of the stratigraphic section through the Hayden, Ariz., tailings embankment of the Kennecott Copper Corp. But the shell can be considered to have a relatively uniform shearing resistance since variations in shear strength are insignificant compared with the dependable

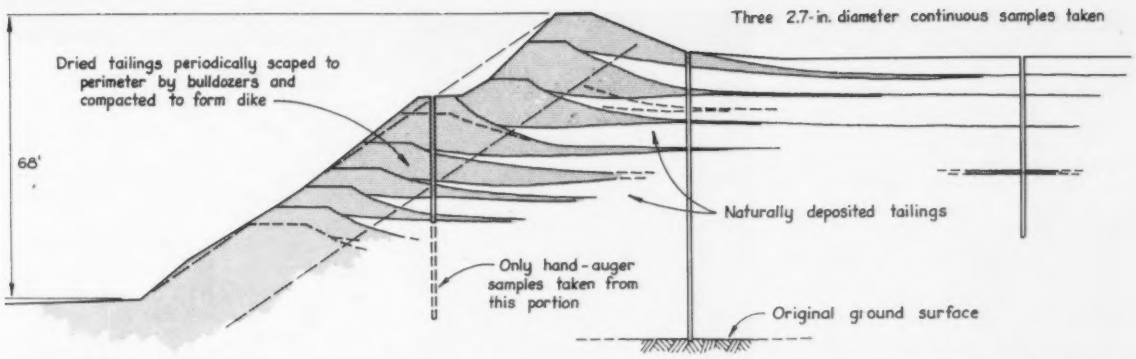

Three 2.7-in. diameter continuous samples taken
Dried tailings periodically scaped to perimeter by bulldozers and compacted to form dike
68'
Naturally deposited tailings
Only hand-auger samples taken from this portion
Original ground surface

FIG. 5 Reconstructed section of the Hayden, Ariz., tailings embankment based on a limited number of soil analysis borings.

absence of excess pore pressures within this zone. Fig. 6 shows how the shell can be idealized for a conservative, though rational, stability analysis.

The material in the "core", behind the shell, cannot be treated as simply; the method and rate of discharging the pulp, the dike-building technique, and the character of the tailings will all affect its strength. From explorations of two of Kennecott's tailings deposits comes graphic evidence of the range in shear strength that is possible: Fig. 7 shows the results of unconfined compression tests on samples taken from the Garfield Utah, pond. Note the small, very uniform increase of strength with depth resulting from the continuous discharge of tailings that maintains a high water table. The other extreme is shown by Fig. 8 which is based on a similar investigation of the Hayden deposit. Here the sporadic filling and intervening periods of drying produced a deposit having a strength that changes greatly and unpredictably within inches!

At present, any intelligent analysis of an existing embankment must be preceded by an extensive exploratory and laboratory testing program coupled with piezometric surveys and a review of the embankment history. Depending on the size and complexity of the embankment, such a program can be expensive, so the operator must weigh its cost against the benefits it may yield in his over-all disposal picture. And it would be misleading not to point out that the limitations in soil sampling and testing may produce too vague an analytical model of the embankment to allow conclusive, quantitative answers for the operator's questions.

Prospective Disposal Areas

When a disposal scheme is to be developed for a new site, however, the soil engineer can unquestionably contribute some definite answers. To realize long-term economy and stability, it is necessary to start correctly both in the choice and treatment of the site and in the methods of impounding and dewatering the tailings. A few of these considerations follow.

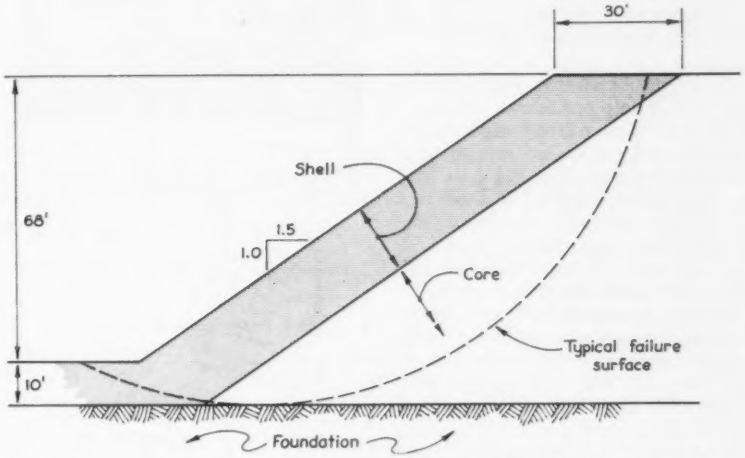


FIG. 6 Further stability analysis is plotted on this simplification of Fig. 5.

The topography of a prospective site merits close attention, for it will control the geometry of the embankment and the method of construction. As the stability of an embankment is largely a function of its foundation, exploration and analysis of the site are imperative. Not only must there be no weak strata beneath the structure, but the foundation should be sufficiently pervious to encourage a downward seepage of water from the pond; surface covering may have to be removed, at least near the toe of the embankment, and some underdrainage facilities may be recommended.

Although a dike of hauled and compacted earth may not be used to contain all the wastes, at least a small initial dike will be required at the start. Even the smallest one is important since the initial dike is the keystone for the stability of the entire embankment as well as a toe drain to control seepage near the face. Selecting materials for the dike and

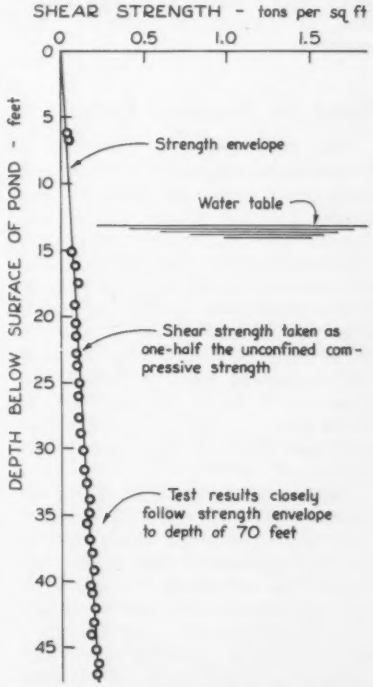


FIG. 7 Increase of shear strength with depth for slimes "normally consolidated" under continuous submergence.

controlling their placement and compaction are specialties of the dam builder.

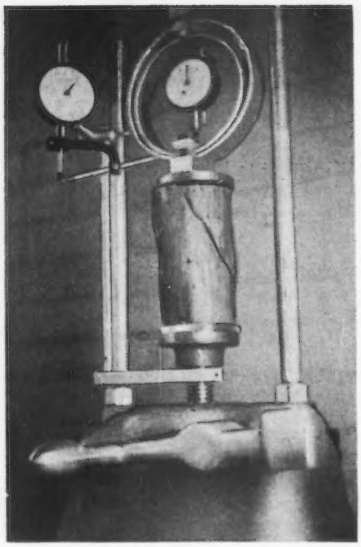
Probably the most critical single feature in the entire disposal scheme is the dewatering method. Related intimately to the dike-raising procedure, the location and operation of the dewatering facilities may determine the depositional pattern of tailings over the surface of the pond and, consequently, the character of material in and near the shell.

Preselecting the general operating policy for a disposal area, and the dike-construction method to be used, represents a singular challenge for the operator-engineer team. The effluent may be discharged from a perimeter pipeline atop the dike, with the dike crest being raised periodically by one of several possible methods. Under this procedure, thousands of feet of pipe will be needed, and possibly cyclones to separate the fine and coarse tailings. Or the dike may be continually built of hauled and compacted fill and the pulp discharged at a single point, thus avoiding the cost of pipe but requiring expensive earthmoving equipment. Or a single, large earth structure can be built at the start. Any of these methods can produce a safe embankment, but the costs will vary over a wide range. The decision will depend on the character of the mill effluent, the availability of borrow material, costs of equipment and manpower, and other factors that may be best evaluated in consultation with a soils engineer.

Need for Empirical Data

The soils engineer, however, is limited in his assistance unless he can know more about the hydraulic impounding of mill tailings, for soil mechanics and earthwork engineering are still essentially empirical in nature. Not even his experience with hydraulic-fill dams will satisfy the need, since he approaches these with the single intent of constructing the most stable structure possible, rather than disposing of waste material at the lowest unit cost. Here the mill operators must help, if they are to be helped.

Close observation should follow the behavior of each existing disposal area, noting both the gross patterns and the apparently meaningless minutiae. The records and observations from many mills, with their variations in effluent properties and operating practices, when collected, may well produce a unified body of relationships to benefit the entire industry and to give the soils engineer a basis for his analytical assumptions.



SHEARING PLANE in the specimen shows clearly in the unconfined compression test apparatus.

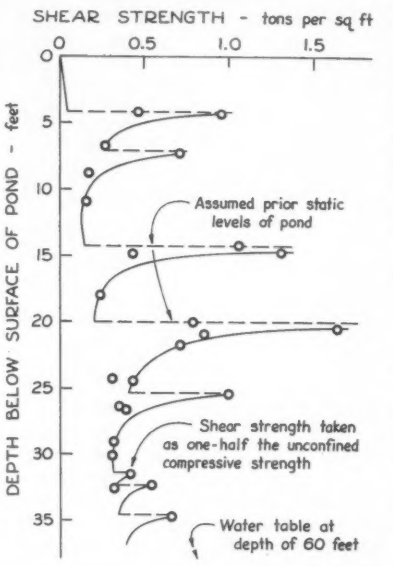


FIG. 8 Increase of shear strength with depth for slimes "over-consolidated" by periodic drying.

The basic problem concerns the segregation and deposition of tailings in the presence of a limited quantity of transporting water. Observations of hydraulic sorting on disposal ponds, and possibly model studies in laboratories, might resolve such typical questions as:

1. Under perimeter discharging, how thoroughly do sands and slimes separate naturally and how are they deposited with respect to distance from the discharge line?

2. How is this sorting and deposition affected by both the grain-size distribution and specific gravity of the tailings and the percent solids of the pulp?

3. At what "thickness" of a specific pulp will natural hydraulic sorting no longer be satisfactory and cyclones be needed?

4. What practices, additives, or pre-treatment might improve natural separation?

5. If pulp is discharged at only one point, will there be any orderly pattern to the separation and can the disposition be controlled (by dewatering methods, diversionary channels or berms, etc.) to preclude slimes from the vicinity of the dike?

Countless other questions might be raised that have not been treated in the standard works on sedimentation, for the silting of reservoirs or the formation of river deltas is accomplished with abundant, relatively pure, transporting water.

Failures of tailings embankments deserve careful study. Every detail attending—especially preceding—a failure should be recorded, the movements and damage measured completely, and, if possible, borings made in an attempt to define the failure surface. If damage is not serious, a failure can be invaluable since its analysis will give a measure of the true shearing resistance as no laboratory test can. There is even a good deal to be said for inducing a controlled failure at a safe location; considerable money might be saved by the knowledge obtained.

Record of rates and depths of filling and periods of drying should be maintained, and samples might occasionally be taken from the surface of the area at different locations and classified by grain-size analyses and, on the finer material, Atterberg limits. Deeper sampling near the face of the embankment could study the variations in deposition, and piezometers installed in the resulting holes could measure water table fluctuation during the filling operations. It hardly need be added that the quality of these data would be greater if an engineer familiar with soil mechanics were placed in charge of the disposal program.

The theory of soil mechanics and the practice of earthwork engineering may, in many cases, assist the mill operator to plan tailings disposal facilities and methods. Unfortunately, unless the operator has maintained a detailed record of his problem, it is difficult to know how much assistance these can offer until the studies have been largely completed. Therefore, only the fullest cooperation and confidence between the operator and the soils engineer will achieve the correct balance of safety against economy in the over-all disposal program.

WHEN Russian blasters changed from conventional blasting to air-decked blasting, their fragmentation results changed also

SIGNIFICANTLY, the yield per meter of drill hole also increased and less powder was needed per unit of fragmented rock.

Air-Decked Charge Improves Blasting

POWDERMEN can achieve exceptionally good fragmentation by a relatively simple technique—using air spaces in the charge column and detonating all holes simultaneously with Primacord. As shown in the above photographs, the results can be significant. As shown in the table, the yield per meter of drill hole can also be increased. Thus, for the same amount of drill hole, there is better fragmentation, increased yield and reduced powder consumption.

For the record, the above well-fragmented blast represents 400,000 tons of taconite broken by an explosive containing 95% AN and 5% TNT. The explosive was loaded into 8-in.-dia holes, spaced 6-m on a 15-m-high bench. The powder factor was 600 g per cu m and the density was about 1 g per cc.

The technique was developed by Prof. N. V. Mel'nikov, member-correspondent of the Academy of Sciences of the USSR. Mel'nikov concluded, after extensive research, that only about 15- to 25% of the energy available from an explosive broke the rock while an additional 1- to 7% moved it—the rest was either transformed into various types of heat energy or was blown out of the hole. He reasoned that there must be some way to get more of the energy to break the rock. Mel'nikov's theories are explained in a paper presented by him to the International Symposium on Mining Research, given at the Missouri School of Mines, Rolla, Mo.

At any rate, he succeeded in getting more of the energy to do work by redesigning the charge. By the design is meant the form of the charge, the form of the charge chamber and, particularly important, the volume ratio between the chamber and the charge. The table, which represents test blasts in limestone, illustrates blasting results from differently designed charges.

Design Test Explosions in Limestone

Design of charge	Yield of limestone per 1 meter of drill hole, m³	Degree of fragmentation, % of stone fragments with linear measurements of centimeters			
		20–40	41–60	61–80	81–100
Solid (not sectional).....	67.7	17.9	14.0	6.9	5.0
Two sections separated by air plug (plug-charge length ratio 1.4).....	82.9	21.9	6.3	2.6	1.8
Solid (not sectional).....	58.4	14.5	14.6	8.9	9.8
Two sections separated by air plug (plug-charge length ratio 0.5).....	65.9	26.9	15.2	6.1	5.1
Separated into 3 sections by sand plugs	54.5	21.2	17.0	10.8	15.1
Separated into 3 sections by air plugs (plug-charge length ratio 0.7).....	63.5	26.1	18.9	2.9	2.8

And the design can be varied to suit the blaster's needs: better fragmentation can be obtained by varying the air space between the charges, and more or less throw can be obtained by varying the air space between the explosive and the walls of the chamber.

The air spaces between the sections of the charge are maintained with the aid of two wooden disks, one above the other, separated by two or three wooden rods. A hole for the detonating cord is drilled through the center of the disks. The ratio of air to charge has to be determined by experimentation but tests in hard rock on an industrial scale show the best fragmentation when the ratio is close to unity (1:1).

Not only should the charges be redistributed but they should also be detonated simultaneously. In this way, explosive wave interference causes an amplification which results in a greater amount of rock breakage. Moreover, the air pockets serve to prolong the time of the build-up of pressure, while reducing the pressure to a certain limit and expanding the effect of the explosion to a larger volume of the rock. That is, the air pockets cause a redistribution of the energy and its fuller application to useful work.

ANNUAL savings through industrial engineering at Kennecott's famed Bingham open pit have exceeded $1.5-million.

How Industrial Engineering Cut Costs

Where Industrial Engineering Cut Costs

Mines	Annual savings (thousands of dollars)	Installation cost (thousands of dollars)
Track equipment linemaster study	10-20	10-15
Spiral drop-cut	intangible	
Top stripping	intangible	
Temporary passing tracks	intangible	
Maintenance workload study, automotive repair	intangible	
Electric shovel pitman study	intangible	
Concentrators		
Justification of replacing 39" tunnel belt with 42"	10	5
Abandonment of #2 dewatering tank —Arthur	10	5
Automatic lubrication system for classifiers	30+	20+
Machine shop study—Arthur	30+	20+
Anti-friction bearing gear drive on #3 elevators	10	5
Study of Hewitt-Robins screens in Symons circuit	10	5
Reproduction and publications center	30+	20+
Continuous operation of lime plant	10	5
Two-way radio communications for mills truck fleet	10	5
Car repair shop study—Magna	intangible	20+

	Annual savings (thousands of dollars)	Installation cost (thousands of dollars)
Smelter		
Smelter organization study	30+	5
Smelter guard activities	30+	5
Office space survey	intangible	5
Study of smelter metal losses	intangible	5
Organization study, Garfield Chemical	intangible	5
Day-pay lines of promotion	intangible	5
Analysis of loaning among work centers	intangible	5
Smelter clothing allowances	intangible	5
Review fork lift requirements	10	5-10
Maintenance and shop facilities	30+	20+
Refinery		
Shearing methods	10	5
Casting warehouse	10	5
Ingot storage	intangible	5
Electrolyte purification automation	intangible	20
Spare geared speed reducers	30+	15-20
Scalper machine crew change	study recommends non-adoption	
Condensate generation	intangible	5
Conservation of culinary water supply	20-30	5

EXTENSIVE I.E. studies include electric shovel operations.

CALCULABLE smelter savings have exceeded $70,000.

at Kennecott

B. BLAIN BRADFORD

INDUSTRIAL ENGINEERING, involving design, improvement, and installation of integrated systems of men, materials, and equipment has proved an effective weapon in the battle against high production costs.

The industrial engineers at Kennecott Copper Corp. have one basic role—to assist management in keeping the operations efficiently competitive. Decreasing ore grades, increasing unit labor and material costs, the competition of a world market, and the increased complexity of modern production methods assure continued emphasis on the industrial engineering function. This article shows Utah Copper Division's present and proprosed uses of its industrial engineering staff. The other western operating divisions of Kennecott in Arizona, New Mexico, and Nevada use management programs similar to those in Utah.

One example: A job description and classification program for all hourly employees has been installed at each of the divisions. Its objective is to eliminate inequities within and between plants and between the four divisions. Similarly, work simplification, scheduled maintenance, salary surveys, capital expenditure controls, organizational planning, manpower controls, and other management programs now have industrial engineering assistance. The Utah Copper Division's industrial engineers are now developing engineered work standards for operational efficiency.

Mr. Bradford is the division industrial engineer for Kennecott Copper Corp., Utah Div.

"Keep Copper Competitive"

Through the years, the Utah Copper Division of Kennecott has become one of the world's largest copper producing units. Due to the pioneering spirit of D. C. Jackling back in the early 1900's, it introduced radical innovations in mining methods. In a similar spirit, present management recognizes industrial engineering methods as the 1961 solution to problems that promise to be as formidable as any faced in the past.

Seven years ago when industrial engineering was first introduced at the Utah property, the usual misconceptions existed which created a real obstacle to getting the program underway, such as:

1. The techniques and tools of industrial engineering could only be applied profitably in repetitive manufacturing industries.

2. While industrial engineering might create modest savings in operations, significant over-all improvements could be obtained only through installation of new equipment and facilities, the discovery of new orebodies, or the development of entirely new processing technologies.

3. Industrial engineering would create an unnecessary "staff empire" that would invade the functional areas of supervision, engineering, industrial relations, accounting, etc., and lead to friction and duplication of effort.

Therefore, industrial engineering was introduced gradually. The Industrial Engineering department was started early in 1954, and at the Utah Copper Division it consisted of 10 men by the end of that year. Efforts were limited generally to getting oriented and in assisting individual

I.E. has significantly reduced the 90,000 tpd ore haulage costs.

members of plant management with specific problems.

Practical experience with industrial engineering, has, over the years, eliminated most of the misconceptions which existed at the Utah Division, and elsewhere throughout the company. Time study and work sampling are extremely valuable fact-finding tools at all Kennecott operations. These, with methods improvements, organizational changes, planned maintenance programs, and manpower controls have resulted in significant cost reductions.

Finally, experience clearly indicates that industrial engineering can develop new programs and procedures, then move on to other areas once the program is installed and working. For instance, the I. E. department was used extensively in the installation of new capital expenditure controls developed by the head office of the corporation, whereas the continuing staff is now provided largely by the Engineering Department. Industrial engineering was used extensively in developing and installing modern wage and salary procedures, the administration of which is now an Industrial Relations Department function. Other activities such as production control procedures, methods improvements, and maintenance scheduling programs have been major activities of the department.

It seems advisable to review briefly some of the past accomplishments of industrial engineering, the present department organization, and its current major areas of activity.

Methods Improvement

At the end of the first year 45 I.E. projects were completed with actual or anticipated savings in excess of $140,000 per year. Since then, savings through industrial engineering have never been less than $500,000 per year, and in 1957 exceeded $1,500,000. Some of these savings could have eventually resulted without industrial engineering services. However, there can be no doubt that the department acted as a catalyst and accelerated the installations by performing much of the necessary data gathering and operations research. Examples of project studies made with resultant benefits are indicated in the table on p 92.

The activity of improving methods is being carried on increasingly by supervisors rather than industrial engineers. All supervisors have been given many hours of training by industrial engineers in the use of analytical and systematic questioning approach, work sampling techniques, flow process charts, flow diagrams, man and machine charts, etc.

There is now a work simplification program in effect at each plant whereby the responsibility rests with the individual foreman to develop and install method improvements in his area, and success in such activities is steadily becoming a factor in foreman promotion and recognition at Kennecott.

There are several advantages in this type of training and responsibility for the supervisors and for the frontline supervisor. It has helped put them on the management team, made their jobs easier, saved money, and, at the same time, the industrial engineer has been able to devote greater portions of his time to other more significant activities.

Methods improvement has received additional impetus through the introduction of a suggestion system plan and a patent award program for both day-paid and salaried employees. These programs now require only a minor portion of the industrial engineer's time—usually limited to the evaluation of savings calculations made by line supervisors. No one is in a better position than the frontline supervisor and the equipment operator to realize that long-established but outmoded practices may cause unnecessary delays, breakdowns, poor communications, wasted steps, etc.

Industrial engineering programs are fully coordinated with technical process improvements and over-all mangement objectives. Nothing contained in this article is meant to minimize the importance of new approaches to drilling, loading, crushing, flotation, converting, refining, and casting operations under development by research and design engineering groups in the rapidly changing technologies of mining and metallurgy.

In fact, in many of these developments, industrial engineers are being utilized extensively by project engineers. Industrial engineers at the Utah smelter are now developing detailed manning plans and procedures for a materials handling system. In 1959, I. E. helped the engineering department develop plans and savings data for a spiral drop cut to the $12-million, 5490-ft tunnel at the Bingham mine.

An effective methods improvement program must involve the majority of salaried employees, and, ideally, involves the majority of all employees. Industrial engineers are still expected to assist supervisors, engineers, industrial relations personnel, and others in the development of projects, but the final over-all responsibility must be carried by each of these individuals.

Organization Planning

Probably nowhere in the management areas has improvement been more clearly accomplished in the past five years than in the general area of organizational planning. The organization at the Utah Copper Division is different in many notable aspects.

Until five years ago, ours was a "line organization." Every activity at a mine, concentrator, or smelter reported to one man, usually a general superintendent. He had an assistant superintendent reporting to him who usually had a general shift foreman under him directing three shift foremen. These foremen, in turn, supervised all the activities of a shift by means of two frontline foremen, e.g. one crusher foreman and one flotation foreman. Reporting to the general superintendent and his subordinates were master mechanics, sampling foremen, production clerks, etc. The old organization structure had

some good points, but it also had some serious faults; and it presented real obstacles to major cost improvements.

Even when operations were reasonably close to one another, each had self-sufficient maintenance forces with inevitable duplication. Also, quality and production count functions were duplicated. Authority and responsibility limits were vague. Cost and performance responsibility seldom went below the plant's general superintendent. A supervisor had some degree of responsibility for the whole smelter or mine, or for a shift or portion of a shift. (The experience at Utah has been that it is very difficult to establish many standards or yardsticks on a shift basis.) Nomenclature was obsolete—a "department" might mean almost anything, and it might consist of three people or 300.

In lieu of this unwieldy structure, an organization was developed on the "work center" concept and the number of supervisory levels was reduced to four—plant, department, work center, and frontline. Frontline supervisors would report to a crusher general foreman, or a converter general foreman, rather than to a shift supervisor.

The "work center supervisor" was given full, 24-hr responsibility for the function, usually involving between 50 to 100 employees. Maintenance for one geographical area was centralized with four work centers reporting to one department superintendent, and staff departments were established on a division-wide basis with relatively well-defined functional responsibilities.

Once these changes had been effected, supervisory titles were standardized; i.e., shift foreman, general foreman, department superintendent, and plant superintendent. Then position descriptions were prepared for all salaried employees and job descriptions for all hourly employees. Relationships between maintenance and operations were standardized. Operating work center supervision was made responsible for determining what maintenance work was to be done and its relative priority; maintenance supervision became responsible for how the work was done, how well it was done, and at what expense. In the interest of developing better communications between divisions, quarterly meetings were scheduled for all maintenance, mine, concentrator, and smelter superintendents, division industrial engineers, etc.

Cost Controls

Management measures cost performance only on the basis of unit costs. Because the nature of the Utah Copper Division is such that payroll and related employment costs exceed all other items of cost, any long-term industrial engineering or supervisory effort that is going to measurably improve unit cost must either increase production of copper or reduce the payroll costs. As indicated, the primary industrial engineering emphasis now is on engineering work standards throughout the operations. The reason is simply that extensive survey data indicate that large improvements are possible in both equipment production rates and operational labor costs by utilizing such standards. Our experience also parallels other industries where the efforts of maintenance supervision and industrial engineering have drastically reduced production delays and reduced maintenance labor costs. For these reasons, division management expects to place even greater emphasis in the next few years on scheduled and preventive maintenance. Also, methods improvements, whether large engineering projects or work simplification projects, can contribute sizeably to both types of productivity improvements.

However, industrial engineers have been active for some time in the recommendation or installation of many cost control procedures that augment the above activities such as:

1. Manpower controls. One of the first effective steps taken toward cost control, was the establishment of a formal manpower control program. All line and staff department heads reviewed their manpower requirements and set up what they considered to be the minimum number of employees needed to run each department satisfactorily. These preliminary lists were reviewed by division management in the light of the many completed industrial engineering studies. Then the basic crew totals were increased by a measured allowance for vacation, sick leave, and absenteeism.

The new total, plus long-term inactives, became the hiring limit to which employment could go on plant management's authority. To exceed this authorization, plant management must obtain specific approval from higher authority based upon adequate supporting facts.

These manpower authorizations had an immediate effect because they started to measure and report something that everybody could understand. It has also been useful in estimating future manpower requirements for various operational schedules, to determine the effect of vacation shutdowns, methods improvements, etc.

2. Objectives. One mistake, but a common one in American industry, has been to spend too much time looking back at last year's costs, last month's production, last week's manpower total, etc., while giving too little time and effort to next month and next year, and even several years from now. For some time now, Utah has prepared annual forecasts in which cost, production, safety, manpower engineering, and improvement goals are clearly stated. They are reconsiled quarterly to the accomplishments set. The result is a knowledge in the division of where it is trying to go, as well as where it has been.

3. Production cost control. In the past, industry has been reluctant to reveal its costs below the level of general superintendent. Today, there is growing appreciation that it is the frontline foreman and the work center supervisor who directly affect most of the costs through their use of labor, material, and equipment for which they are responsible. Consequently, increasing attention has been given to the development of cost controls and reports that will inform each level of management, including the line foremen, how well his costs and performance compare to standards. At the present time these reports are based on the previously mentioned manpower authorizations and historical material costs, but completed standards are in the developmental stage and will be incorporated into these production cost controls.

Present I.E. Organization

The industrial engineering department at Utah Copper Division employs 65 individuals in the department having varying backgrounds: Some have been production employees, some line supervisors, and some have worked in other industries. Individuals with engineering and science degrees are preferred, but some have had no advanced formal education. Since the department serves as an excellent reservoir for first- and second-line supervision, there is no specialization in the department, and it is organized on a geographical or plant basis.

The mine, concentrator, and refinery have used industrial engineering since early 1954, and the smelter since January 1959. The industrial engineering supervisor at each plant and a staff industrial engineer in the Salt Lake City office report to the division industrial engineer. Each plant industrial engineer has from 12 to 17 individuals under his supervision in classifications ranging from clerk-typist, to junior industrial engineer, to industrial engineer and senior industrial engineer.

MEN IN THE NEWS

Williams

Van Dornick

Dr. Norman C. Williams and Edward Van Dornick are both vice presidents of Beryllium Resources, Inc., both are married, both are authorities in their respective fields, both contributed fresh thinking to beryllium development. There the similarity ends.

BERYLLIUM RESOURCES, INC., expects to become the nation's first significant supplier of beryllium ore within the next few months when it begins commercial mining operations in the Topaz Mountain region of Utah. Tentative plans revealed by president Bruce Odlum call for a 300 to 500 tpd mill to process the as-yet unidentified non-pegmatite ores which assays approximately 10 times richer in BeO than most commercial grade pegmatites.

Two key figures are primarily responsible for the Beryllium Resources bid to become an important supplier of the strategic mineral—Dr. Norman C. Williams, the geologist who staked out more than 3,000 acres of claims containing some 3,000,000 tons of beryllium-bearing ore in Utah's north central desert, and Edward Van Dornick, the chemical engineer who developed a flotation process to economically beneficiate the Topaz ore.

Dr. Norman C. Williams

At the age of 43, Dr. Norman C. Williams is one of the nation's old-timers in beryllium, his experience in the field extending back some 20 years.

As vice president and chief geologist of Beryllium Resources, Inc., Williams has uncovered a domestic source of beryllium ore which he believes "can make the United States self-sufficient for years to come." The scope of this statement becomes clear when it is kept in mind that in 1960 only 5% of the U.S. ore requirement came from domestic deposits.

A professor of geology at the University of Utah, Williams is accustomed to choosing his words carefully, imparting to his prediction an aura of credibility. Beryllium, in minor amounts, had actually been known in the volcanic ash of the Topaz region for more than 50 years. "It kept gnawing at me," Williams says, "that beryllium was occurring where it shouldn't have been, so far removed from any pegmatites."

He and his graduate students set about coloring and mapping the area in 1956, without significant results. Then, in the fall of 1959, with the availability of a berylometer, sizeable deposits came to light. Some were in locally exposed tuffs at the surface, others under shallow caps of lava, and some in 5 to 30 ft beds lying up to 700 ft below the surface.

"The trouble had been," Williams admits, "that all our thinking about beryllium had been shackled to pegmatites." The experience has helped amplify one of Williams' basic attitudes about the mining industry. "Discovery of new deposits," he says, "is going to depend not only on the application of new technology, but, more importantly, on the application of creative imagination. The industry has too long been prone to rely on the sheer technician or 'cook book' approach in its search for deposits."

This type of conservatism, in general, has pervaded the mining industry, Williams feels, and has served to hold it back. "For instance," he says, "the industry has been extremely deficient in fundamental research to establish new uses for its products. It has just been in the past year or two that there has been an awakening to the fact that you can't just produce something and sit back expecting somebody to buy it from you."

If Williams is critical of mining it is because of his concern as an academician who has witnessed a steadily dwindling enrollment in mining schools. Born in Salt Lake City, Williams drifted into mining by accident. He had set out at the University of Utah, intent on a law career, but an optional geology course changed his mind. He was, and still is, an ardent outdoor enthusiast, and his indelible reaction upon being exposed to geology was, in his words, "My God, people get paid for this?"

Getting into the field immediately, Williams spent several summers as a field assistant to the U.S. Geological Survey under its first chief, Herbert E. Gregory. This had whetted his interest in beryllium, and following his graduation from the University of Utah he enrolled in Columbia University and commenced working on a doctoral thesis on beryllium. However, his studies were cut short in 1942 when, on the recommendation of Columbia's geology head Dr. Paul F. "Pappy" Kerr, Williams was singled out by Brush Beryllium as their chief geologist.

Brush, at the time, was closely involved in the Manhattan project, and was pressed to develop a crash program of exploring and developing new pegmatite sources for the vital metal. Williams' search ranged over the United States, Canada, Central and South America. At the time he had joined Brush, the nation's beryllium ore consumption had been about 2500 tons a year. By the end of the war the consumption had doubled.

From the outset, Williams had wanted to teach. He returned to his Alma Mater in 1947 as an assistant professor, but retained his ties with Brush as chief consulting geologist. "I found out that teaching is no way to make a living," Williams reflects, "so I had to take on additional private consulting work in order to supplement my income." Another revelation about teaching quickly became apparent. "A Ph.D. is the equivalent of a union card." Thus, he returned to Columbia and in 1951 gained his doctorate, resumed teaching at Utah, and was soon elevated to a full professorship.

He also continued his extra-curricular consulting work, a pursuit that he feels is a matter of principle. "Universities should realize that it benefits them when their professors have freedom to engage in outside industrial work. Not only does this permit professors to earn a living income, but enables them to stay abreast of the new developments in the field. It is industry, and not the universities, which has the financial ability to risk the big chips in scientific research."

Among Williams' clients had been Floyd and Bruce Odlum who had retained him in connection with their uranium interests. The Odlums had expressed a desire to enter into the exploration and development of beryllium. Brush Beryllium, eager to encourage a new ore source, agreed to Williams'

participation in the newly-organized Beryllium Resources, Inc. in May 1959.

Although his home in the suburbs of Salt Lake City is only some 180 miles from what is probably his most significant discovery, Williams' work has taken him all over the world. His most recent junket was made late last year when he and Bruce Odlum investigated beryllium sources in Africa. He has published some two dozen technical papers and is co-author of the book, URANIUM published in 1955. Professional affiliations include the Geological Society of America, American Association of Petroleum Geologists, and the American Geophysical Union.

Under an arrangement with the University of Utah, Williams teaches only from January through May, leaving ample time for his work with Beryllium Resources and for purely pleasurable pursuits. His affinity for the outdoors has remained undiminished. His wife, Helene, whom he met while attending Columbia, and his three sons share his enthusiasm for camping, fishing, hunting and golfing. Indoor hobbies include wood and metal shopwork and the raising of tropical fish. The latter is a joint venture with his sons, Gregory, 18, Gary, 14, and Galen, 10.

One of Williams' favorite indulgences is appearing as a technical expert in litigation involving geological engineering. His professional services are often sought by the courts, and he accepts such invitations with unconcealed relish. "I thoroughly enjoy getting into a battle of wits with an attorney," he admits, ". . . on my subject."

Edward Van Dornick

His knowledgability, coupled with an imposing Dutch name, often cause the inventor of the Beryllium Resources flotation process to be addressed as 'Dr. Van Dornick.' "I appreciate the gratuitous degree," he says, "but my formal academic training is limited to a B.S. degree in chemical engineering."

Born in Menominee, Michigan 53 years ago, Edward Van Dornick early displayed a scientific bent. "As a kid," he relates, "my brother and I made one of the first all-electric radio sets. We made all the equipment and components ourselves, and were very proud of it. Of course, when we plugged it in it went up in smoke." Instead of becoming discouraged, Van Dornick developed an all-consuming interest in science. "My work and my hobby," he says, "is research and development of applied science and engineering."

So thoroughly absorbed is he in this singular endeavor, that he normally spends some 16 hours a day at his vocation-avocation. The time is divided between the two tpd beryllium flotation pilot plant in Huntington Park, and his own private 800 sq ft laboratory near his home in Pasadena where he is currently studying the application of ultrasonics to chemical reactions. His wife, Anne, understandably takes a firm stand against any home workshop.

Although he enjoys fishing, Van Dornick has not baited a hook in six years. Nor does he belong to any professional or other societies. Any activity not specifically aimed at scientific development is considered by Van Dornick a frivolous waste of time. "Sometimes I just lie awake at night, thinking of what to invent." He regards such mental activity as a form of relaxation as well as a form of conditioning. The pastime has engendered a unique ability to think in terms of complete processes, often visualizing entire flow sheets before a single mark has been committed to paper. It is to this quality, coupled with his extensive background in catalysis, that Van Dornick attributes his success in developing a flotation process for beryllium.

"Most of those who had done flotation work thought about it in terms of mining rather than in terms of chemistry. It's as though I might be asked to write a report and I would do it automatically in English because that's what I know and that's what comes naturally to me. But the possibility might not occur that I could express myself more clearly in German or in French."

For several years prior to becoming associated with Beryllium Resources in 1959, Van Dornick set out to find an economical way of floating beryl. As this process neared perfection the company's sizeable Topaz holdings became a significant factor.

In addition to Van Dornick's flotation process, new techniques for the economical processing of low-grade American beryllium ores include:

The "Mincon" process, a heat-flotation method of extraction developed and being used by Mineral Concentrates and Chemical Co., Inc.

A chemical process, "not a flotation technique", currently being developed by United Technical Industries, formerly Larsen Industries, of Salt Lake (E&MJ, April p. 114).

For Van Dornick, beryl flotation was reasonably predictable inasmuch as beryl is of known chemical composition and its crystalline structure allows application of the normal ore processing methods. Topaz ores, however, presented special problems. The beryllium mineral in these ores is still to be mineralogically identified. Furthermore, their clay structure makes them difficult to handle and the material forms slimes. Instead of evident crystalline structures, the Topaz material consists of a solid solution of beryllium in a calcium fluoride host, making it difficult to separate distinct particles of the mineral from the gang material.

During the past seven months, however, Van Dornick has been working on the adaption of reagents to the Topaz ores and reports that by making reagent and flowsheet variations, the process is effective for both Topaz and beryl ores.

The training that led to this development began specifically in 1935 when Van Dornick was graduated from the University of Michigan and went to work for Foster Wheeler in New York. "I cut my teeth on petroleum refineries and petrochemical plants," he recalls.

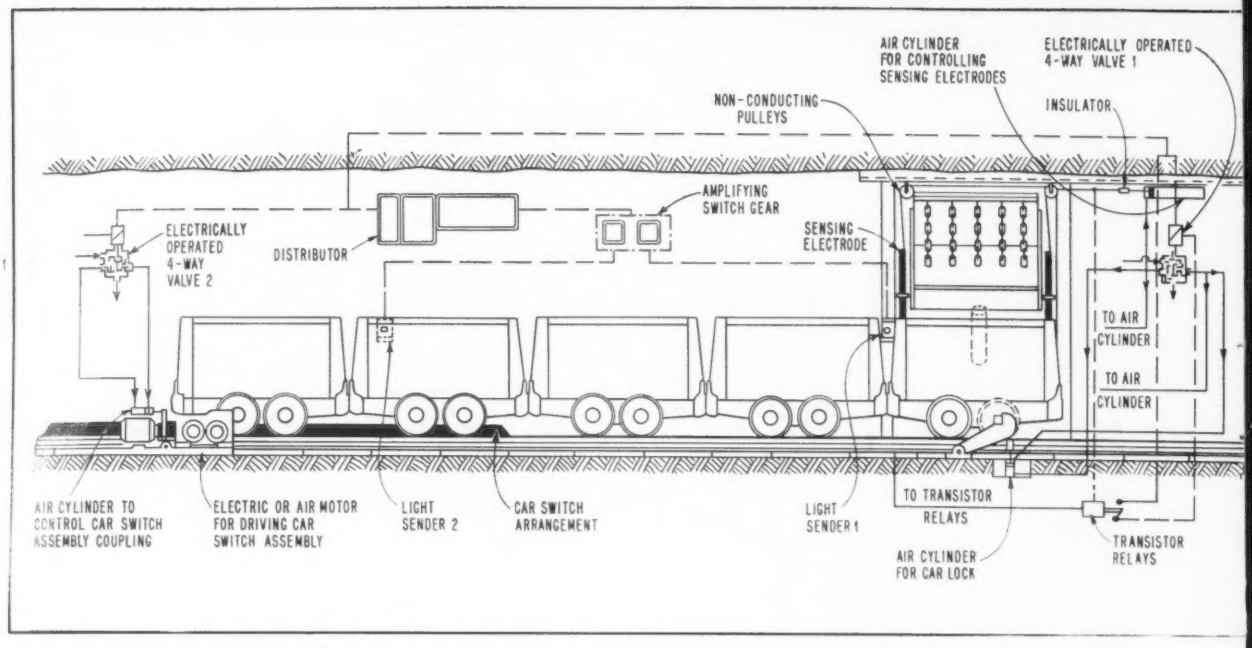
In 1945 he became a private consultant in New York. Partially motivated by a desire to escape the eastern winter, he joined Aramco in San Francisco in 1948 as director of the engineering department's oil facilities division. The refuge was short-lived when some months later Aramco moved its offices to New York. "It was such interesting and fascinating work, I decided I could tolerate the weather."

During the first 15 years of his career, Van Dornick estimates that he participated in the design, engineering or economic studies of some 150 different types of plants. When Aramco decided to switch its headquarters to Arabia in 1952, Van Dornick, who regards sandstorms as unpalatable as snowstorms, moved back to California. In response to an ad, he leased a 1,000 b/d specialty refinery near Los Angeles. After redesigning and rebuilding the plant he entered the manufacture and sale of various solvents, absorption oils, jet aircraft fuels, and high octane blending stocks. The firm, Hydrocarb, which Van Dornick still owns, continues to operate but strictly as a marketing unit. Van Dornick had given up his lease on the refinery to return to Aramco in 1955, first in London and then in the Hague as design coordinator.

Again he was plagued by climate. "It was humid, cold and entirely disagreeable." Returning to Southern California in 1957, he joined Macco Corp. as vice-president and director of the firm's refinery division. It was while he was active with Macco that Van Dornick became acquainted with Merrill MacAfee, an expert in mining and beneficiation work, who had been retained as a consultant for the company's mining and heavy chemical work.

"As it happened, MacAfee was also a consultant to Beryllium Resources. This coincidental circumstance led to talk of Van Dornick's early beryl flotation work which was based on the theory that catalysis was adaptable to minerals flotation. The previous laboratory work seemed to have substantially proved the feasibility of the process and, as a result, Bruce Odlum set up Dynamic Metals Corp., with Van Dornick as vice-president, specifically to prove out this feasibility. MacAfee, an expert in mining and beneficiation work, was retained to provide the application knowhow."

In January of this year Dynamic Metals was merged into Beryllium Resources and Van Dornick was named a vice president of the surviving company. Meanwhile, Hydrocarb also is destined for a re-emergence. Later this year Van Dornick will begin building a new facility on a 1½ acre site in Los Angeles which will produce and supply reagents for Beryllium Resources. In addition the plant will be involved in research and development on processing other ores.



CARS are pushed to the loading chute by an electric motor. Two coordinated electric eyes relay information to the electrically operated valves which operate the car lock and loading gate. The sensing electrode determines when the car is filled.

How "Sachtleben" AG Automated Underground Loading & Cut Costs

"SACHTLEBEN" AG, the leading West German pyrite producer, is automating its underground loading system in its mine at Meggen (Lenne).

The operation is fully automatic, with only one man needed to supervise the work. By means of a series of electric eyes, electrical control equipment, and pneumatic valves and cylinders, an empty train is run under a loading chute and filled one car at a time. When the last car has been loaded, a horn signals a trammer. Should the chute hang up or run out of ore, the horn gives a warning signal, and the operation stops.

Decision to automate the loading system was based on a planned 50% reduction in loading costs (amounting to 0.37 DM—8.84¢ per ton at the current rate of exchange)—thus justifying the necessary capital outlay. As a result, the system illustrated above was built and tested, and additional units are now planned for the mine.

At "Sachtleben" AG's mine, some 650,000 tpy of ore are mined and processed, of which 500,000 tons represent pyrite-zinc ore and the remainder barite ore and zinc concentrates obtained through flotation of pyrite-zinc ores.

During World War II, when foreign ores were not available, production of pyrite ore soared to 1-million tpy. Although the current 500,000-tpy production covers about 40% of Germany's pyrite ore requirements, competition from foreign ores resulted in the mine's reduced output. Therefore, to strengthen its competitive position, "Sachtleben" AG commenced a study of mine and plant operations with a view of providing more efficient and safer working methods.

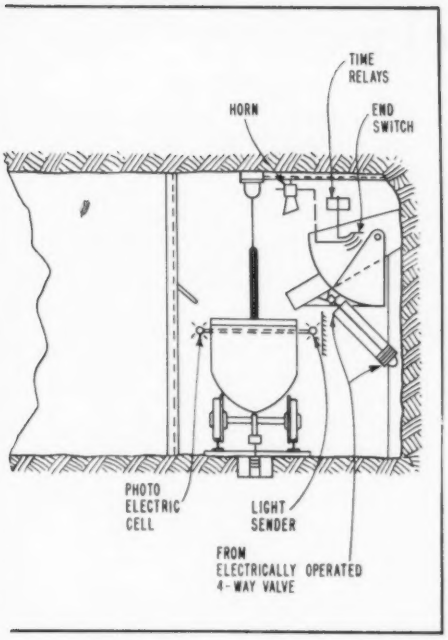
One area investigated with particular care because of material savings promised was underground loading and haulage. For instance, total loading costs (cars loaded through chutes with air-operated roll gates) when operating on the current 650,000 tpy basis amount to about 480,000 DM, ($114,624), or 0.74DM per ton.

The automated car loading system serves an underground bunker established to store barite ore mined on two upper levels preparatory to rail transfer to the main shaft loading station. Daily tonnage passing through the 1.5x1.5x130-m bunker varies from 300 to 350.

At the bottom of the bunker, a loading chute equipped with an air-operated roll gate with chain spillage protection loads into doorless or box type mine cars. The 143x76.5-cm cars hold 0.75 cu m (1.7 tons) of ore. The system is designed to automatically load cars from the bunker discharge chute, as well as automatically spot empty cars under the loading chute. Only one operator is required to supervise the complete installation.

Equipment units incorporated in the design of the car loading system include: (1) the air-operated loading chute roll gate with chain spillage protection, (2) an air-operated car lock arrangement below the loading chute, (3) a chain-type car puller with a specially controlled coupling device actuated by an electric motor, (4) two electrically operated 4-way valves, one controlling the air cylinder actuating the roll gate serving the loading chute and the air cylinder actuating the car stop, and the other controlling

Data presented in this article were abstracted from an article by Betriebsdirektor Dipl.-Ing. Kurt Wild of "Sachtleben" AG published in the December 1960 issue of ERZMETALL.



HORN signals trammer when the train is filled or when anything goes wrong.

the air cylinder which controls the coupling device of the car puller layout, (5) two electric eye installations, (6) an electric amplifier unit, (7) a transistor amplifier, (8) four time relays, (9) two sensing electrodes actuated by an air cylinder, (10) a contact switch, (11) a signal horn and (12) an electric distributor unit.

How It Works

Here is how the car loading system works: Assume that an empty train has been switched into loading position and the first car is standing directly under the loading chute, as shown in the drawing, with the electric controls switched on. The beam from light sender 1 will pass through the open space between the first and second car and hit the photo cell receiver on the opposite side.

The weak current impulse generated in the cell is then increased by an amplifier switch enough to actuate the electrically operated 4-way valve 1. This will happen only when the beam from light sender 2 is interrupted by an empty car. In other words, the system will work when light sender 1 is in closed circuit with the photo cell and light sender 2 is blocked off from the photo cell by an empty mine car. Therefore, additional cars must follow the car under the loading chute at all times.

The electrically operated valve 1, once actuated, will simultaneously (1) cause the respective air cylinders to raise the lever of the car lock assembly and thus hold the car under the loading chute safely in place, (2) open the roll gate on the loading chute, and (3) lower the two sensing electrodes. The car is now being loaded. Material will continue to fall into the car until it reaches the tips of the sensing electrodes. This should be accomplished in less than ten seconds; if not, the signal horn will go into action.

Contact of the sensing electrodes with the ore mass closes a control circuit extending from a transistor relay through the rails, car and the ore. Closing the control circuit, in turn, actuates the operating circuit.

To make possible closure of the control circuit, it is imperative that the suspended sensing electrodes are properly insulated. This has been done by placing an insulator unit between the air cylinder and the suspension cables and by passing the cables over pulleys made from nonconducting material. Insulation valence should exceed 250,000 ohm, otherwise switch failure will result.

When the control circuit has been closed then the coil of the relay actuates valve 1, which will reverse the switch made during the loading period, thereby (1) raising the sensing electrodes, (2) closing the chute gate, and (3) releasing the car stop. As soon as the electrodes have reached the rest point above the loaded car, the electric eye circuits will be bridged by the transistor relay and held in this state for several seconds by a time relay.

Upon closing of the chute gate there is actuated a contact switch on the loading chute, which, in turn, operates valve 2. This unit switches on, via an air cylinder, the special coupling arrangement of the car puller causing the train to move slowly toward the loading chute.

Operations Are Repeated

Within a few seconds, or as long as the light sender circuits are bridged, the car to be loaded must stand before light sender 1 so that the circuits can be interrupted and their effect neutralized. The car puller then spots the car under the loading chute. When this has been accomplished the light sender 1 again is in closed circuit with the photo cell opposite and the loading and switching operation described are repeated until the last car of the train has been loaded. The light senders 1 and 2, after the trains have been removed, are then in closed circuit with their opposite photo cells, and as a consequence the entire loading system is out of operation. Blasts from the horn signal this to the shaft station. The horn is then switched off and the loading system is started up again when a new empty train is to be loaded.

In the event that the car secured below the chute gate is not filled, either because the bunker is empty or because there is a hangup in the chute, it is assumed that the transistor relay then will not cause valve 1 to reverse the switch made during the loading period and consequently will not close the control current circuit relay and the chute gate will remain open. This is not the case, however, for if the car is not filled within 10 sec and the control current circuit via the sensing electrodes is not closed, then there is actuated by means of a time relay another contact of the end switch on the loading chute which closes the chute gate and sets off the horn to signal existing trouble to the shaft station.

In view of the fact that the light sender 1 is in closed circuit with the opposite photo cell and thus provides contact, valve 1, which controls the chute gate and sensing electrodes, is actuated and subsequently opens the gate, with the contact switch, in turn, reversing the operation after ten seconds. The operations can be repeated in the hope that they will restart the flow of ore from the bunker. If not, then the car loading system is closed down by hand.

Car Puller Design

Design and operation of the car puller layout is important. The unit must have a minimum of inertia during switching operations, especially while pushing the train through the loading system. The moving car is the instrument on which the continued control of the car loading system depends and it is the light sender-photo cell 1 circuit operating between the open space between two cars that sets the system in motion. As the space between two cars is only 14 cm and quickly rolls by the beam from the light sender, it is important that trains travel at a set speed, independent of load carried and number of cars in train. Performance of the car puller must meet this requirement.

Early tests made showed that this could not be obtained with a car puller layout actuated by an air cylinder drive system. As a consequence, a car puller employing a chain drive was adopted and found satisfactory. It is driven by an electric motor through a multiple disc friction coupling which engages and disengages the chain system through an air cylinder controlled by valve 2. The company plans to install additional car loading systems in other parts of the Meggen mine, including those where pyrite is mined.

New Look at Jet-Piercing Developments

J. J. CALAMAN & H. C. ROLSETH

Since 1947, when the Linde Co. introduced the jet-piercing process for primary blast hole production in hard rock, both the blowpipe and auxiliary equipment and procedures have continually been modified and improved. The following report is part of the authors' paper, "Technical Advances Expand Use of Jet-Piercing Process in Taconite Industry", delivered during the International Symposium on Mining Research at the Missouri School of Mines last Feb 22-25, and outlines the jet-piercing evolution.

The authors stated that taconite, as used in the report, referred not only to the magnetic lean iron formations of the Mesabi Range, but also to any iron-bearing rock not merchantable as iron ore in its natural state and which cannot be made merchantable by simple methods of beneficiation.

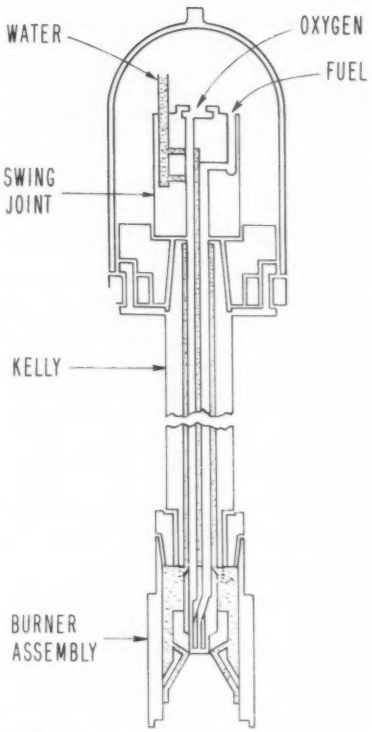
THE THREE MAJOR COMPONENTS of a jet-piercing blowpipe are the swing joint, kelly, and burner assembly. Oxygen, water, and fuel are introduced into the rotating blowpipe through the swing joint. The round triple-fluted kelly is standard oil well drilling equipment. Oxygen and fuel are carried through separate tubes on the inside bore of the kelly to the burner assembly. Water is brought to the burner in the remaining space inside the kelly. The burner assembly consists of four main parts; the header, fuel injector, burner, and reamer shell. The header is a permanent part bolted to the bottom of the kelly onto which the fuel injector and burner are screwed. The liquid hydrocarbon fuel is atomized by kinetic impact of the gaseous oxygen as it enters the rear end of the pear-shaped combustion chamber. The burner gases are exhausted through divergent nozzles to produce the piercing jets. The reamer shell functions as a hole sizer, protective casing, and water jacket for the burner. The flame jets produced from this blowpipe when operating at standard flows of 10,000 cfh of oxygen and 40 gph of fuel oil have an energy concentration for a combustor having 15 cu in. of volume.

Burner Changes

Changes in the burner, the heart of the piercing process, have brought about the substantial improvement in process performance. The evaluation of experimental burner designs involves long and detailed tests under production conditions in the field to study the effect of each design variable. A continuing program of burner development has been made possible through the fine cooperation of mine operators in permitting this test work under actual production conditions.

The present standard burner is model 6T36—the thirty-sixth model of a 6½-in. burner. Burners of various sizes were tested before the 6½-in. model was used as the standard, and the 6T36 was actually about the one hundredth development model burner that was designed over a period of five years. In evaluating experimental burners, the 6T36 is always used as the yardstick. The standard burner has an equal flame distribution to all jets. The results show that the increased vertical component of the flame gases reduces penetrating efficiency about 10% in the backbreak zone (crest holes) but enhance performance 5 to 10% in the relatively solid undisturbed rock behind the backbreak zone. Although some burners did show a superiority for certain ranges of rock pierceability, none was universally better than the standard 6T36. However, by combining the best features of a number of these burners, a new series was recently designed which, from the preliminary results, looks extremely promising. This model, the 6T56, incorporates a slight change in configuration of all three flame jets. Angularity of the inclined jets has been reduced 5° with respect to the burner axis. The vertical flame jet which is parallel to the burner axis was moved ¼ in. further from the burner axis. This design was directed primarily at improving performance in the semi-spallable rocks without sacrificing the efficiency in the good spalling zones. It appears that we are on the way to accomplishing our objective—have achieved 12% increase in penetration rate in the semi-spallable taconites. Tests are continuing with this burner in the Michigan jasper formations to develop additional data before proceeding with adoption of the new model.

In addition to the 6½-in. burners rated at 10,000 cfh of oxygen, tests have also been run on a series of 6½-in. burners rated at 12,000 and 15,000 cfh. Results of the 12,000 cfh burner as the yardstick for a number of types of iron formations are shown in Table 2. Compared to the 10,000



JET-PIERCING blowpipe—most of the modifications have occurred in the burner.

Table 1—Evaluation of Experimental Burner 6T52

Test Area	Average Piercing Speed, fph: Standard 6T36 Triple Jet	Burner 6T52 Single Axial Flame	% Difference
Poorly Spallable Ore....	11.1	11.6	+ 4.5
Semispallable Ore.....	16.2	14.8	− 8.6
Good Spalling Ore.....	28.9	20.5	−29.0

Table 2 — Performance Comparison 6½-in. Burners 12,000 cfh Oxygen vs. 10,000 cfh Rating

Iron Formation	Average Piercing Speed, fph: 12,000 cfh	10,000 cfh	% Difference
Mesabi Taconite...	36.1	28.7	+25.8
Mesabi Taconite...	37.1	31.5	+17.8
Labrador Specularite.	40.4	29.4	+27.3
Labrador Specularite.	31.5	26.5	+18.8
Michigan Jasper.....	21.3	18.0	+18.3
Michigan Jasper.....	18.8	16.4	+14.6

Mr. Calaman is sales manager—jet-piercing, and Mr. Rolseth is development engineer, Linde Co., Div. of Union Carbide Corp.

cfh burner, the 12,000 cfh model shows a 15 to 27% increase in penetration rate in the ore zones tested. The increased efficiency will not only offset the 20% increase in process fluids consumption rate, but also increase machine productivity and reduce total drilling costs. In view of these excellent results, one Mesabi jet-piercing operation standardized on the 12,000 cfh burner last year.

Test results thus far with the initial model 15,000 cfh burner now show enough improvement to be economically advantageous. However, further investigations along this line are planned.

As in rocket operation, performance of the jet burner is also influenced by the fuel-oxygen ratio to a limited extent. Thermodynamics of rocket combustion indicates that optimum flame temperature and jet velocity are obtained at fuel-rich mixtures of reactants. Stochiometric ration of fuel oil and oxygen combustion is about 0.281 lb of fuel oil per lb of oxygen. A fuel ration of 0.326 is desirable in the semispallable rocks and ores and a still richer mixture of about 0.355 is indicated for the good spalling rock. Apparently, the bushier flame jets obtained with this rich mixture accelerate rock removal in the good spalling zones.

Production Jet-Piercing Speeds

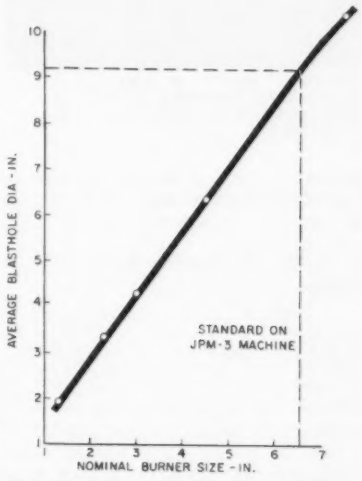
Taconite formations are highly variable both physically and mineralogically. As a consequence, a wide range of production piercing rates has been experienced. The following table lists penetration rates obtained in various rock and iron ore formations.

Rock or Iron Formation	Jet Piercing Speed, fph
Oxidized and altered taconite,	14
Lower cherty magnetic taconite, Area A	25
Lower cherty magnetic taconite, Area B	12
Upper cherty magnetic taconite, Area C	23
Lower slaty taconite	11–12
Michigan quartzite	30
Michigan jasper (magnetite specularite)	19–40
Labrador specularite	23–40
Michigan conglomerate	20
Michigan diorite	12
Michigan sericitic Dike	9
Michigan argillaceous Iron Formation	14
Arkansas syenite	18
Massachusetts granite	20
Potsdam sandstone (St. Lawrence Seaway)	20

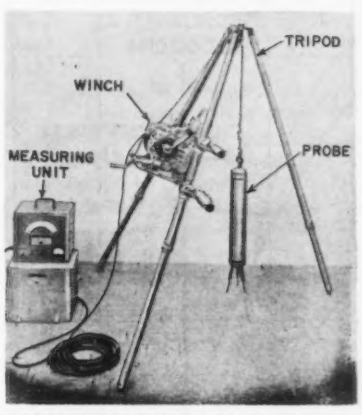
Through many years of experience we have been able to develop information on how various rock properties and formation conditions affect piercing speeds. A recent series of tests was devoted to the study of the effects of surface weathering, oxidation, and discontinuities on penetration rate. This work involved a comparative analysis of piercing speeds for the top third, middle third, and bottom third of each blast hole in a number of areas exhibiting various degrees of spallability—conclusion is that piercing speed generally improves as the rock becomes solid, less weathered, and less oxidized.

Table 3 — Effect of Backbreak, Fissures, and Cracks on Piercing Speed

Location of Blastholes	Area #1 Spallable Ore	Area #2 Poorly Spallable Ore
Crest Row	25.4	11.5
Second Row	25.9	13.9
Third Row	28.8	12.0
Fourth Row	29.4	11.8



DIAMETER of jet-pierced blasthole as related to the size of the burner.



CONTOUROMETER with three-fingered probe determines blast-hole shape.

While all drilling methods appear to be adversely affected by natural fissures and cracks and also by the backbreak induced by blasting, indications are that jet piercing is less affected than mechanical drilling. The influence of these factors on jet piercing is shown in Table 3 which gives penetration rates of blast holes with respect to their location to the crest of the bench. In this tabulation, we see a 13% inefficiency in the crest row when compared to the fourth row of blast holes in Area 1. In Area 2, this relationship is not as apparent, and it appears here that the degree of spallability is the controlling factor and probably overshadows any effects of broken or cracked structure. Nevertheless, multiple row drill patterns are held desirable to minimize the effects of inefficiency in the backbreak zone.

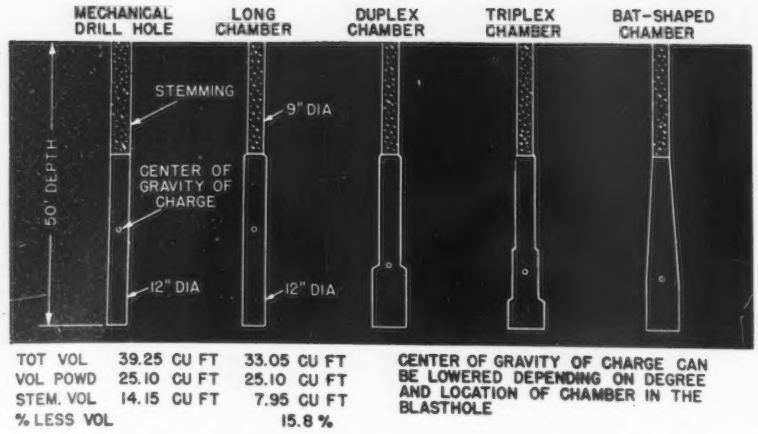
The walls of a jet-pierced blast hole are somewhat irregular and diameter of the hole varies with the spallability of the strata being pierced. Experiments with various size burners has established the approximate relationship between nominal burner size and actual hole size. The curve shows that actual hole volume is about twice that indicated by the nominal burner size. An attempt to correlate average blast hole diameter is estimated to be 9.2 in. A 100% change in piercing speed to about 36 ft per hour on this curve reduces blast hole diameter about 10% to 8¼ in.

Because of the irregular diameter of jet-pierced holes it became apparent early in the development of the process that effective loading of explosive required more specific information on the shape of the hole. Consequently, an electromechanical three-fingered caliper was developed for this purpose. The entire unit, the "contourometer", includes a probe, suspension mechanism, and the electronic measuring instruments. The operating range of this device is 4½ to 24-in. in dia. From the data obtained with the contourometer, it is possible to chart the actual contour of the blast hole.

Blasthole Chambering Practices

While mechanical drilling methods all produce a relatively smooth bore cylindrical hole, this shape is not necessarily the optimum for a blasthole. On the contrary, we believe that any one of a number of the jet-pierced blasthole shapes may be more efficient from a blasting standpoint than a smooth bore cylindrical hole such as the one shown on the next page.

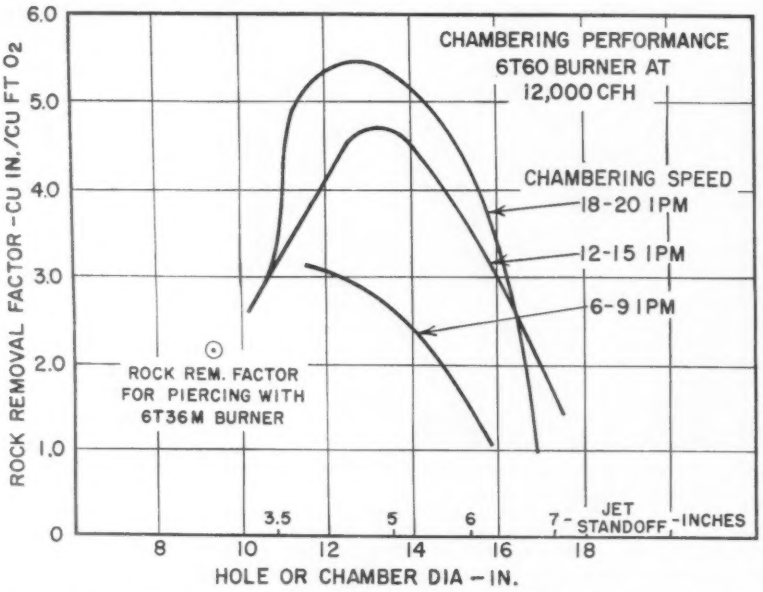
In addition to providing hole size flexibility in one tool, bottom cham-


MECHANICAL DRILL HOLE
LONG CHAMBER
DUPLEX CHAMBER
TRIPLEX CHAMBER
BAT-SHAPED CHAMBER
STEMMING
9" DIA
CENTER OF GRAVITY OF CHARGE
50' DEPTH
12" DIA
12" DIA
TOT VOL 39.25 CU FT 33.05 CU FT
VOL POWD 25.10 CU FT 25.10 CU FT
STEM. VOL 14.15 CU FT 7.95 CU FT
% LESS VOL 15.8 %
CENTER OF GRAVITY OF CHARGE CAN BE LOWERED DEPENDING ON DEGREE AND LOCATION OF CHAMBER IN THE BLASTHOLE

ADVANTAGES of drill hole bottom chambers are: 1) reduces amount of subgrade drilling; 2) confines the blasting agent; and 3) reduces amount of necessary stemming.

Table 4 — Chambering Test Results 12,000 cfh Piercing Burner in Mesabi Taconite

Method	Chambering Time, Min.	No. of Passes	Feed Rate, IPM	B. P. RPM	Chamber Dia (in.)	Rock Removal Rate Cu In./Cu Ft O_2
A	16	2	6	15	12.0	1.44
B	16	2	6	45	12.5	1.57
C	16	4	12	15	13.3	2.26
D	16	4	12	45	14.5	3.08



LABRADOR CHERTY iron formation tests with a special chambering burner indicate that large blasthole chambers can remove rock more cheaply and efficiently.

bers have a number of other advantages including (1) assurance of breaking bottom (elimination of hard toes) on large drill patterns, (2) reduction in the amount of subgrade drilling, (3) reduction in the depth of fractured rock to be penetrated in starting holes in subsequent benches, (4) greater confinement of the blasting agent, and (5) reduction in the amount of stemming required compared to an equivalent sized mechanical drill hole.

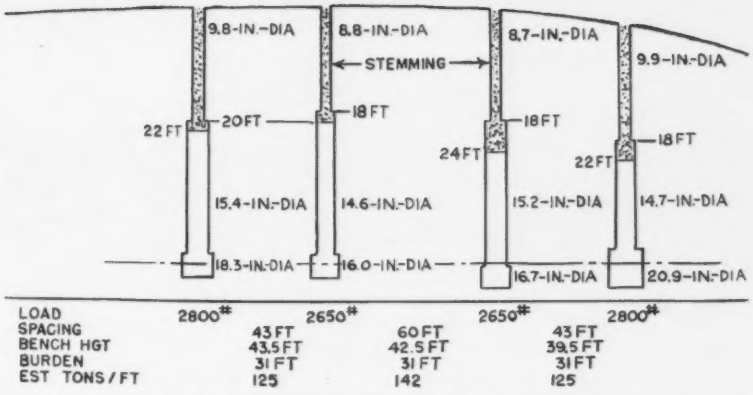
According to practices at the various jet-piercing operations during the past year, it is estimated that chambering is done on about 90% of the blastholes produced. Chambering time may range from 10 to 36 minutes per blasthole depending on procedure.

A recent investigation of chambering methods at one property yielded some interesting results. Procedure D produced more than twice as much chamber volume for the same amount of burning time as procedure A. It is also apparent that surface velocity of the flame across the rock is an important factor in determining rock removal rate. For example, in procedure A. surface velocity ranges from about 35-47 ft/min whereas in procedure D, the range is 100-170 ft/min. It appears that there is an optimum rate of heat input into the rock for maximum rock removal rate. Results of similar tests in Labrador cherty iron formation with a special chambering burner confirm these conclusions. Results are extremely promising inasmuch as chambering rock removal factors obtained in producing chambers up to 13-in.-dia are 2½ times greater and at 17-in.-dia are equal to the rock removal factor for piercing the basic 9-in. blasthole.

Last year, two experimental blasts were made in hard, massive Labrador iron formation with super-chambered jet-pierced blastholes. Blastholes were chambered with multiple chambering passes at various feed rates ranging from 6-to 20-in.-per-min. Contourometer measurements were made to check diameter after each pass. The first blast consists of one row of six holes with chambers ranging from 11.5- to 17.8-in.-dia. Burdens varied from 30 to 25 ft as bench height varied from 34 to 25 ft. Actual breakage was estimated at 80 tons per ft. Under similar conditions a 43-ft bench would be expected to produce 100 tons per ft of hole. The muck pile heaped up about 25 ft from the face.

The second shot (four holes) was pierced on the new face and shot against the buffer of the muck from the first shot. Burden on the shot was 31 ft with spacing ranging from 43 to 60 ft for holes ranging 41.5 to 46 ft deep. The blastholes had chambers up to 20-in.-dia containing upwards of 200 lb per ft of commercial TNT/AN/H O slurry blasting agent. The holes loaded with 2650 to 2800 lb slurry each carried from 20 to 24 ft stemming. An estimated powder factor of 1.21 lb per cu yd broke well over 100 tons-per-ft. The shot has not been dug out as yet so we do not know the true condition of the bottom. However, it is our belief that the concentrated bottom charges had no trouble breaking to planned bench grade on the 43-ft spacing. Fragmentation in this portion of the muckpile looked good; however, large slabs

and boulders in the 60-ft spacing area tend to show the limitation of the last spacing. Nevertheless, it appears that a well fragmented 100 tons per ft at a powder factor of 1.25 is readily obtainable. We would like to emphasize that final evaluation of all aspects of these two experimental shots must await digging of the muck. However, it is our opinion that super chambered flame-shaped blastholes obtainable with jet-piercing constitutes a major contribution to drilling and blasting technology and will be instrumental in reducing drilling and blasting costs. A preliminary analysis of jet-piercing cost indicates that a super chambered jet hole designed to break 100 tons per ft will yield a 25% reduction in drilling cost per ton of fragmented ore compared to a basic 9-in. jet hole designed to break 50 tons per ft.



THOUGH RESULTS have not yet been fully correlated, tests last year in massive Labrador formation show flame-shaped blastholes can cut drill-blasting costs.

Process Fluids Supply

Jet-piercing differs from other drilling methods in that it requires the supply of process fluids which include gaseous oxygen, fuel oil, and water to the piercing machine. Safe and efficient procedures and equipment have been devised for accomplishing uninterrupted process fluid supply.

Oxygen Supply Methods and Equipment

Important advances have been made in the storage, handling, and delivery of oxygen to jet-piercing machines during the past ten years. The first jet-piercing installation at a taconite plant at Aurora, Minn., in 1949, was supplied with gaseous oxygen from a permanent high pressure storage unit via a 1-in. steel and copper line operating at 600 psi. Capacity of the storage unit was 132,000 cf. A pressure regulator at the end of the pipeline reduced the pressure to 250 psi and delivered the gas through a 1-in. rubber hose 300-ft. long to the jet piercing machine. However, by improvements in burner design and distribution systems, it was possible not only to reduce operating pressure but also to maintain burner efficiency. A subsequent installation at a Michigan Jasper operation uses a 2½-in. steel pipeline operating at 160 psi. The pipeline is fed by a permanent liquid oxygen storage and gasification unit having a capacity equivalent to 310,000 cf of gas. The unit automatically feeds gas to the pipeline as demanded by the jet-piercing machine.

For the larger jet-piercing operations having three or more JPM-3's, Linde on-site gaseous oxygen producing plants were installed. The gaseous oxygen produced in these plants located on the customer's property is charged directly into high pressure (2400 psi) semi-trailer gas transports of 75,000 cf capacity. At the standard demand rate of 10,000 cfh at the JPM-3, the gas trailer is sufficient for one shift operation before returning to the oxygen plant for recharging. The oxygen plant is backed up by liquid oxygen storage unit to insure uninterrupted supply in the event of a plant outage. Thus far, approximately 30 semitrailer gas transports are in operation at jet piercing installations. We have found from experience that one oxygen truck driver can keep seven operating JPM-3's supplied with oxygen.

In late 1960, a new portable liquid oxygen distribution system was placed in service at a taconite operation on the Mesabi range. The latest advances made in the handling of a cryogenic fluid such as liquid oxygen were employed in this system. The trailer unit weighing 14 tons loaded holds the equivalent of 150,000 cf of gaseous oxygen. This is equal to two of the 24-ton 75,000 cf semi-trailer gas transports and is sufficient for operating a JPM-3 at least two full shifts. This unit can be filled in about ½ hour from 1½-million cu ft storage tank located at a railroad siding at the mine site. Liquid oxygen is shipped to the mine in oxygen tank cars. The trailer-mounted liquid oxygen storage tank known as a 150 VCC unit is connected to a skid-mounted electrical vaporizer which in turn delivers gaseous oxygen to the JPM-3 through 300 ft of 1½-in. oxygen hose at an operating pressure of 150 psi. Operation of the vaporizer and pressure control equipment is automatic. It is apparent from the foregoing that practical and proven equipment and methods are available for handling oxygen for any size jet-piercing operation.

Fuel Supply

The JPM-3 machine has integral tanks with a capacity of about 550 gal of No. 2 fuel oil. Consumption ranges from 240 to 285 gal per jet shift. Refueling of the JPM-3 is done by a fuel tank truck at the drilling site.

Water Supply

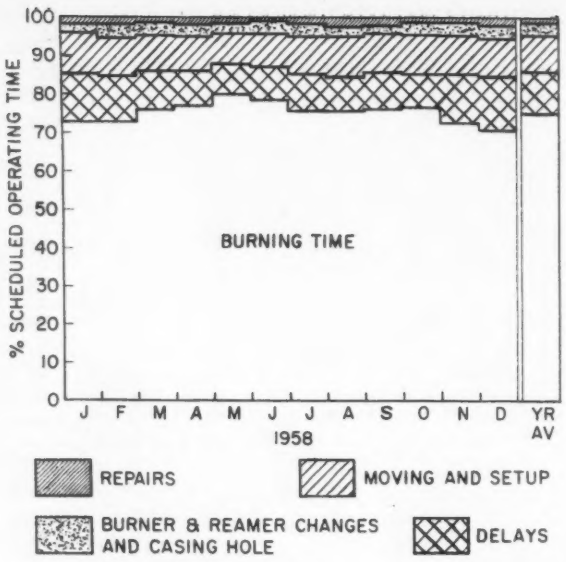
Water supplied to the JPM-3 was initially handled by pipelines. However, subsequent operations went directly to water wagon distribution. Water is stored at the drilling site in a 6,000-gal insulated and electrically heated crawler-mounted water wagon. This unit is refilled during the course of the shift by a 6,000 gal tank truck which is equipped with a 1,000-gpm pump driven by an oil motor. In a matter of minutes, the water load can service seven JPM-3's per shift.

Production Statistics

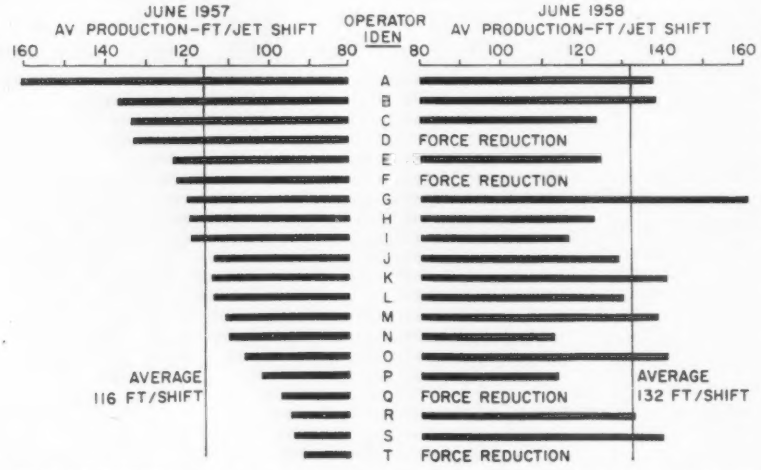
By virtue of the advances in equipment and techniques developed through the years, the productivity and operating efficiency of the piercing machine have risen markedly. Based on composite production figures from five operating properties in 1959, the following jet-piercing statistics apply:

Composite Jet-Piercing Performance in Taconite and Jasper

Average production per scheduled 8-hr shift	96.5 ft
Burning time factor per shift	73.5%
Average piercing speed, ft per burning hour	18.2 fph
Average piercing speed including chambering	16.35 fph
Maximum production record for one jet shift	276 ft
Maximum piercing speed record for one blast hole	47 fph



FULL YEAR'S time distribution chart (1958) for a multiple JPM-3 shows that the unit had almost no repairs downtime.



ONE MONTH'S comparative production chart indicates that JPM-3 maintained crude ore requirements while permitting a substantial reduction in the work force.

Productivity of one JPM-3 machine on the basis of 1000 jet shifts per year is about 3.8-million tons of crude ore based on the above statistics and a breakage of 40 tons per ft of blast hole. However, at one operation the JPM-3 production rate is over 5-million typ per machine.

One measure of the efficiency of the jet-piercing machine is the burning time factor. The trend has been toward increased efficiency with a minimum of downtime as evidenced by the improvement in the annual burning time factor which increased from 69.8% to 76.5% during the period of 1957-1959. This means that during 1959 at this operation, burning time averaged 6.12 hours for every scheduled 8-hour machine shift.

Breakdown of Operating Functions for a Twelve-Month Period

Burning time (piercing and chambering)	75.5%
Moving and setup	9.4%
Change burners and reamers	2.1%
Casing blasthole	1%
Repairs	1.6%
Delays	10.4%

It can be calculated from the above statistics that for every 100 hr burning time, repair time during scheduled shifts amounts to only 2.12 hr. Observations also show that taking into account repair or bad order time during non-scheduled time periods the machine availability is on the order of 95%. Based on observation of a number of mechanical drills operating in the same hard massive taconites, we find an estimated availability of about 75%.

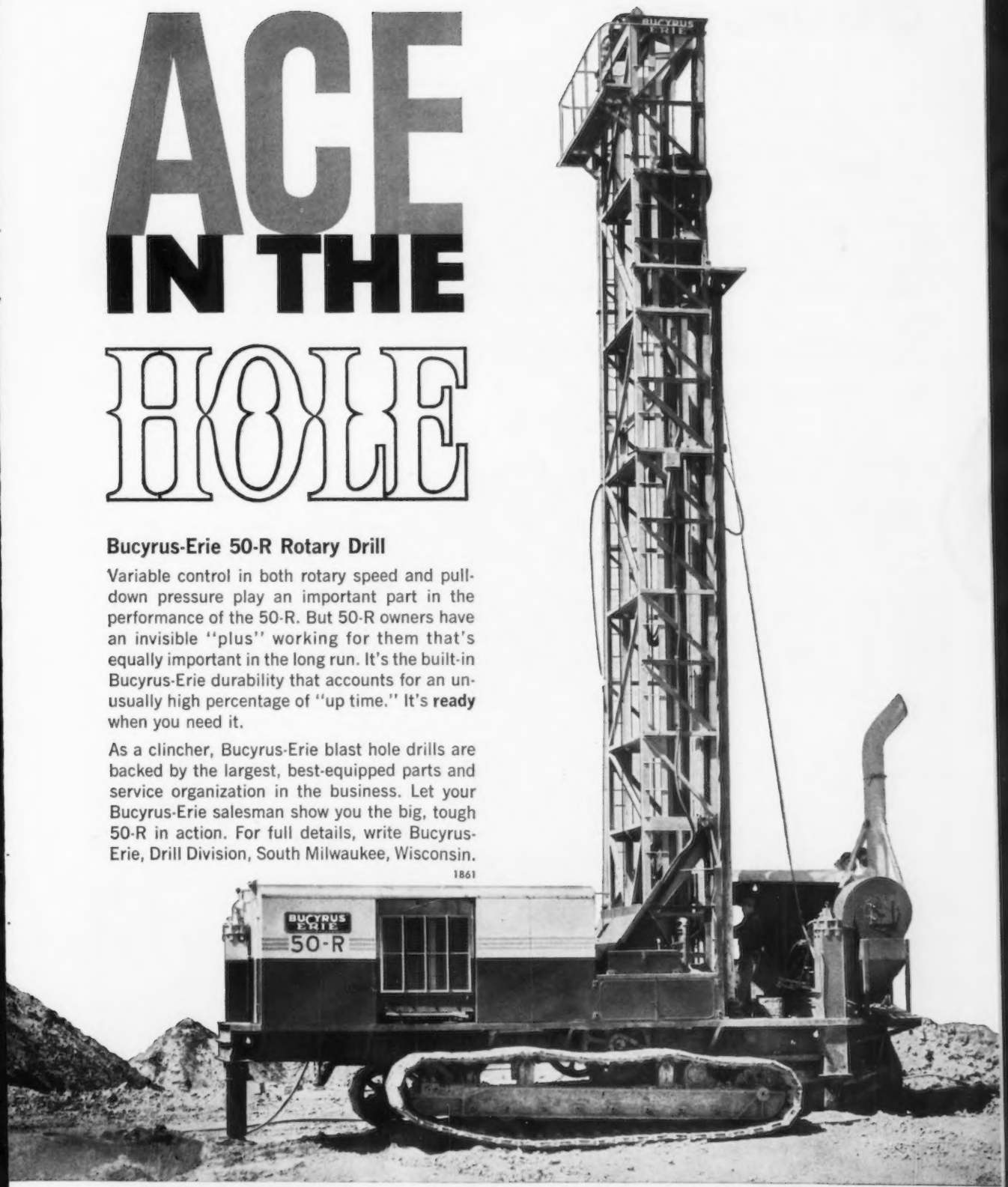
Machine Design and Improvement

Since it was introduced, the jet-piercing machine has undergone three major design stages.

Work is currently in progress on the redesign and engineering of a new model jet-piercing machine based on the eight years operating experience with the JPM-3 models. The new model, designated the JPM-4, will incorporate a wider track base for increased stability on rough terrain; a rugged tripod mast which will improve rigidity and eliminate the need for backbraces; fuel tanks installed in the deck to lower the center of gravity, increase the work space in the cab, and facilitate arrangement of equipment for maximum accessibility; a 20% increase in hp on the propulsion motors and improvement in propulsion controls to permit independent directional and speed control on each crawler for easier turning, spotting, and maneuvering; new type pneumatic controls for determining blowpipe cable tension and resistance to penetration; automatic blowpipe feed rate compensating controls for minimizing the human element in determination of the rate of feed of the blowpipe; and use of a top rotary drive on the blowpipe which will permit use of a simple heavy wall tube for the blowpipe body instead of the present triple-fluted kelly bar. The objectives of all of these changes are: (1) further simplified and reduced maintenance on machine and blowpipe components; (2) further increased operating efficiency and machine availability. These factors should be reflected in reductions in over-all operating costs.

The present 22 production jet-piercing machines are all in operation in the Lake Superior Iron District, and are accounting for about 90% of the approximately 40-million tons of crude ore being produced annually from that area. It is expected that during 1961 the process will spread into the Canadian iron ranges and may even be demonstrated in Europe. Interest in the process has been world-wide as evidenced by the over 200 rock and ore samples forwarded to our Newark Development Laboratory for evaluation of their piercing characteristics, and hopefully we will be applying the process in several of these areas in the near future.

ACE IN THE HOLE



Bucyrus-Erie 50-R Rotary Drill

Variable control in both rotary speed and pull-down pressure play an important part in the performance of the 50-R. But 50-R owners have an invisible "plus" working for them that's equally important in the long run. It's the built-in Bucyrus-Erie durability that accounts for an unusually high percentage of "up time." It's **ready** when you need it.

As a clincher, Bucyrus-Erie blast hole drills are backed by the largest, best-equipped parts and service organization in the business. Let your Bucyrus-Erie salesman show you the big, tough 50-R in action. For full details, write Bucyrus-Erie, Drill Division, South Milwaukee, Wisconsin.

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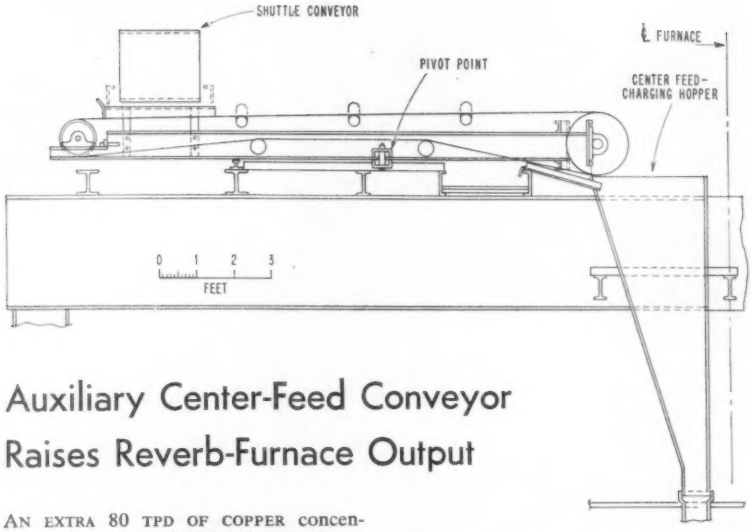
OPERATING IDEAS

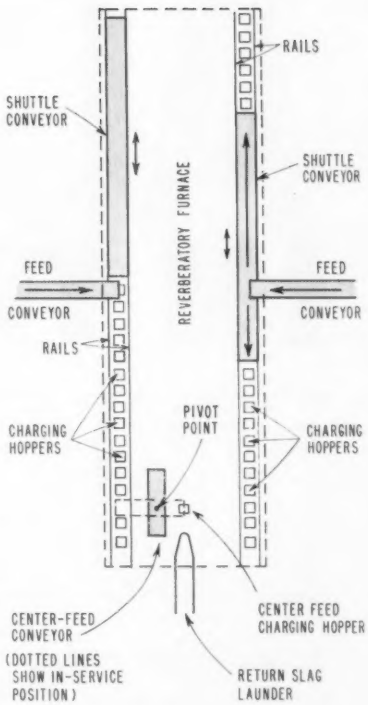


Auxiliary Center-Feed Conveyor Raises Reverb-Furnace Output

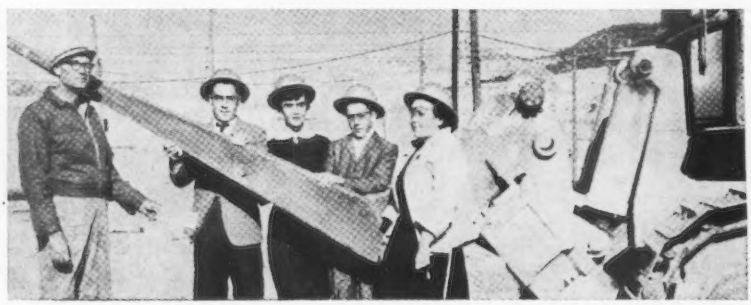
AN EXTRA 80 TPD OF COPPER concentrates are now smelted by the reverberatory furnace at Kennecott's Hayden, Ariz., smelter, thanks to the auxiliary center-feed conveyor shown here.

Before the center-feed arrangement was installed, furnace output tended to fall when high-insol furnace feed failed to move off the furnace walls. The furnace, an all-basic-refractory unit with a Detrick-type suspended arch (see E&MJ, June 1959, p100), was designed to be fed through a series of hoppers, 32 of which are situated above 32 charging holes along each side of the furnace. A shuttle-type conveyor belt, moving along rails mounted above the line of hoppers, moves concentrates from the storage bin and drops them into the furnace.

It was found feasible to maintain a normal smelting rate by introducing part of the concentrates through a new charging hole located in the furnace's center. Drawing at right shows location of center-charging hole. The 24-in. auxiliary conveyor is mounted on a pivot-point, and can be swung lengthwise of the furnace and out of the way, during normal side-charging, or crosswise, so as to drop its load into the center hopper. When in use, it receives concentrates from one of the side shuttle-conveyors.



Conveyor, charging hopper, and construction details were made in smelter machine shop from salvage materials. A 2-hp geared motor moves the belt at 193.5 fpm. Head and tail pulley centers are 14 ft apart.



LEE BATEMAN (left) shows family, Ronald, Gloria, Donald, and Mrs. Bateman, the "stinger" that is now used to shift track at Kennecott's Chino Div.

DAUGHTER Gloria examines track-cleaner designed by her father.

Dozer Modifications Improve Track Work at Chino

LEE BATEMAN, dozer operator at the Santa Rita Mine of Kennecott Copper Corp., has developed a more efficient and economical method of track shifting than was previously used.

As reported in KENNESCOPE, a single D-8 tractor, with standard ripper attachment, is used to shift track, which is lifted by hydraulic cylinders and moved until the desired length of rail has been shifted. Previously, two D-8 tractors, each with boom and spreader bar, were used to shift track. One tractor lifted a section of track and moved backward while the other pushed the section with dozer blade to the new location. In addition, two trackmen were needed to operate the clamps four hours daily. The new attachment is called a "stinger."

Another modification, developed by Bateman, is an attachment on the dozer blade that permits cleaning under rail ties.

Under the Chino Mines Division's suggestion award program, which pays the suggestor 25% of the money his ideas save the company per year, Bateman received $8579 for the track shifting idea and $4085 for the blade attachment idea, making a total of $12,664.

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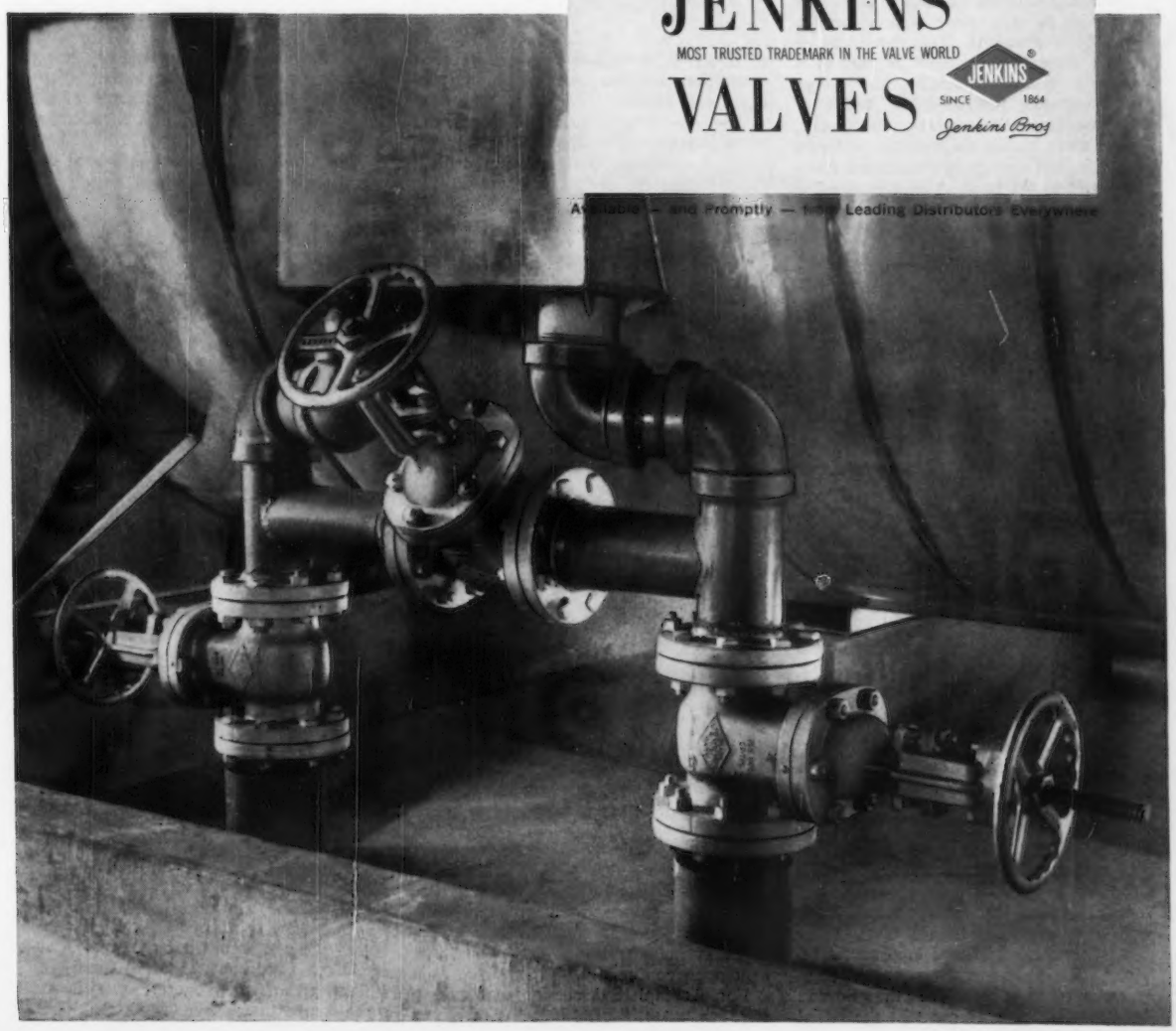


OPERATING IDEAS *(Continued)*

Concave Bit Increases Drilling Speed, Reduces Wear

A CONCAVE chisel drill bit is giving some South African miners faster drilling speeds and more footage between regrinds.

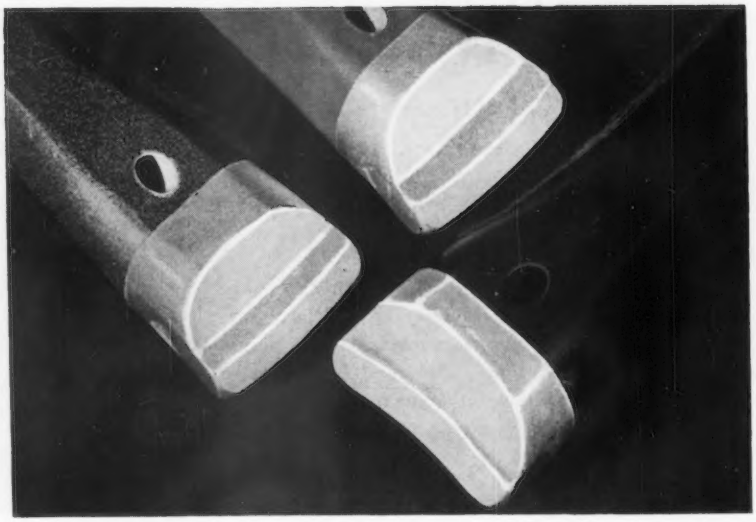
Tests made by Hard Metals Ltd. in several Witwatersrand gold mines show also that the tungsten-carbide bit produces coarser particles and consequently less dust. The concave shape allows sludge to be drawn away from the ends of the bit where it might otherwise cause unnecessary wear.

The new product, known as the "saddleback" tip, originated during experimentation at the University of Witwatersrand, under the control of Dr. H. H. Schlössin. Designed primarily to reduce wear, the bit was made concave in the form of a parabola. The shoulders of the bit were also designed as part of a parabolic curve. Originally, the design was computed mathematically but later tests confirmed the mathematical theory.

The main reason the new tip performs better is that energy is transferred more efficiently to the rock. A greater number of effective blows are delivered at each revolution, and the resulting sludge particles are coarser.

The new shape tends to focus the stress waves within the cylindrical volume of the rock that is being drilled, and this energy is concentrated in the formation of a hole, instead of being fanned out and, to some extent, dissipated in other directions. Because of the increased efficiency, there is a reduction in cost per ft of drilled hole.

A special grinding wheel has been designed to sharpen the bits.



SADDLEBACK TIP (right), developed to concentrate more energy in the hole, is giving faster drilling speeds and more footage between regrinds in South Africa.

Bureau of Mines Will Test Eight-Piece Concrete Sets at Garrison

EIGHT-PIECE concrete sets will be installed this spring at the Montana Prosphate Products Co. mine at Garrison, Mont., as part of a research project being conducted by the Spokane research office of the U.S. Bureau of Mines. The units are made with expanded shale aggregate to save 40% in weight and reinforcement is with ⅝-in. free tension steel cables.

Bureau officials said that five-piece sets have been tested in the Coeur d'Alene mining district for the past two years but the Montana installation will be the first use of an eight-piece set. The sets have been thoroughly tested for load and stress at the Spokane laboratories of the bureau with photo stress gauges and load cells. A miniature version of the set was made up in plastic and checked on a polarizer to determine the load and transfer of load through the joints. Units also were tested for failure.

Webster Anderson and George Krempasky, mining methods research engineers, are in charge of the Bureau project. They pointed out that the initial cost for concrete is higher but it is believed to be more economical than wood over a long period, particularly for use in main haulage levels that would be kept open continually.

For a complete discussion of concrete sets, see E&MJ, Sept. 1956: "With These New Techniques, Concrete Sets Prove Practical."

The article, by Robert A. Elgin, discusses the sets installed by Banner Mining Co., Lordsburg, N.M. Banner installed prestressed concrete sets in its three-compartment Bonney shaft.

GEORGE KREMPASKY, mining methods research engineer, Spokane office, U.S. Bureau of Mines, examines a section of a concrete set that was tested for failure.

Special Report to Users of Caterpillar Equipment: Custom TRACK SERVICE

Custom Track Service saves coal stripper $3298 by adding 3800 hours to track life

A coal stripper, ripping and 'dozing rocky overburden 7 days a week around the clock, was averaging 2300 hours of life before he *replaced* most of his totally destroyed track group parts. At the suggestion of his Cat Dealer, the stripper tried new, larger-size undercarriage parts. By following recommendations of the dealer's undercarriage specialist at 2440 and 4030 hours, the undercarriage went a total of 6100 hours with only pin and bushing replacements . . . and all but the shoes were rebuildable instead of scrap! Up to this point, Custom Track Service saved the stripper a $3298 cash outlay; and since he was able to rebuild the links and reuse the pins and bushings instead of replacing with new assemblies, he realized additional savings.

PAST EXPERIENCE

ALL BUT SHOES READY FOR SCRAP PILE AFTER 2300 HOURS

PRESENT EXPERIENCE

COMPLETELY REBUILDABLE EXCEPT SHOES AFTER 6100 HOURS

HOW CUSTOM TRACK SERVICE HELPS LOWER COSTS

Custom Track Service, available only from your Caterpillar Dealer, is designed to help you get the most possible service from undercarriage parts and thus cut costs. Factory-trained specialists are ready to help solve your particular track problems. They can give sound recommendations to help you get the most from your undercarriage.

They can advise you on maintenance . . . help you tailor the many special undercarriage parts and track options available to meet various job conditions. As a result, costs per hour go down and profit and machine availability go up.

These undercarriage specialists are backed by modern track undercarriage rebuilding facilities manned by experienced personnel . . . by the largest and most complete stock of standard and special application parts available . . . by Parts Exchange Assemblies that keep tractors working and earning.

Check with your Cat Dealer and learn how Custom Track Service can help you to reduce costs.

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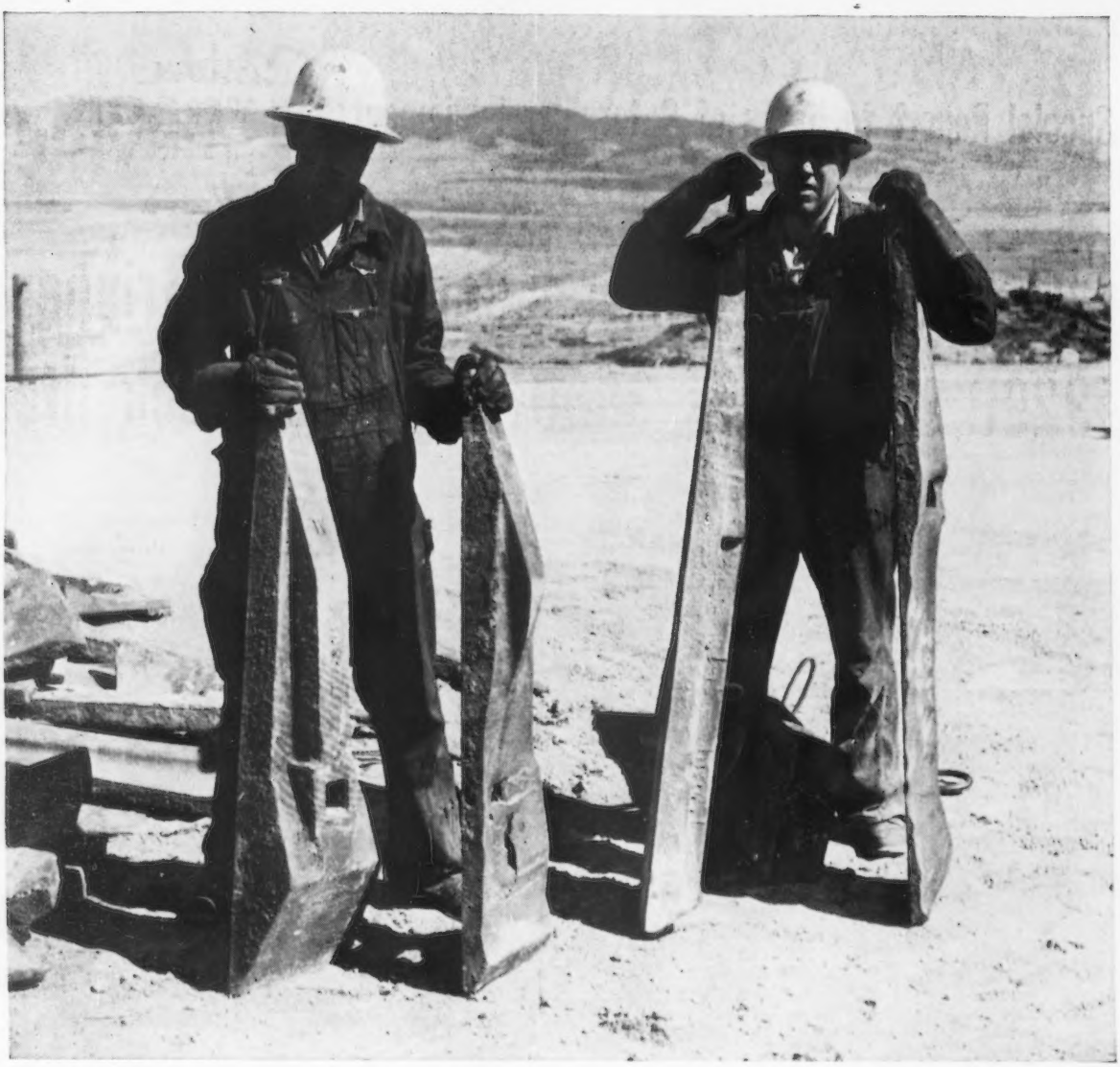

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Ni-Hard liners are good to the last ¼ inch... cut mill downtime, cut mill costs

To save thousands of hours of downtime ...thousands of dollars in repair and replacement costs...that's why The Anaconda Company installed Ni-Hard* nickel-chromium-iron alloy liners in twenty ball mills grinding abrasive copper ore.

The proof is in the picture. The worn liner on the far right shows you how Ni-Hard liners keep their contour right down to the last fraction of an inch. That's because Ni-Hard liners not only have outstanding resistance to abrasive wear but also have a uniform wear rate so that you get higher efficiency and longer working life out of the design of your Ni-Hard liners.

Try a set of Ni-Hard liners in your mills. Just contact the Ni-Hard producing foundry in your area. They'll be glad to discuss the design characteristics best-suited for the liners in your mills, glad to give you further information on Ni-Hard liners and how they can help you cut mill-operating costs.

For further information on Ni-Hard iron feed spouts, pipe elbows, and many other parts where abrasion-resistance is required, just drop a note to Inco. We'll send you your free copy of the useful 58-page booklet, "Engineering Properties and Applications of Ni-Hard" and a list of Ni-Hard producing foundries.

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The compact transistor makes possible a 35% reduction in size of this new transmitter/receiver. There are no vacuum tubes to wear out. No damage due to vibrations.

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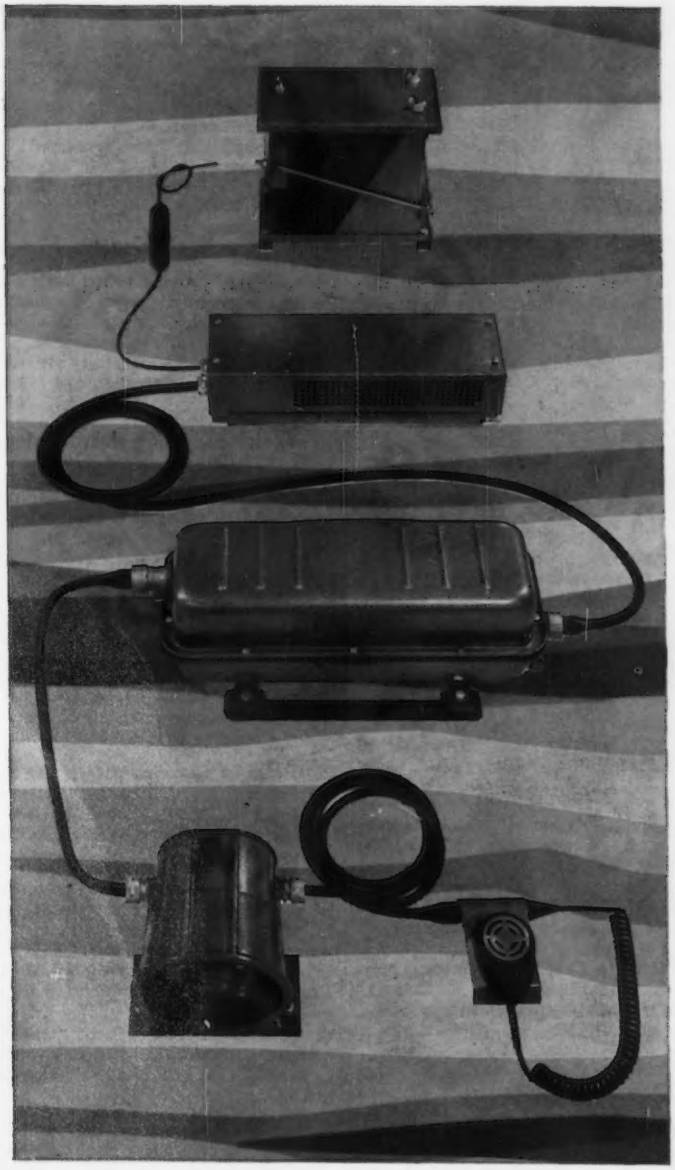

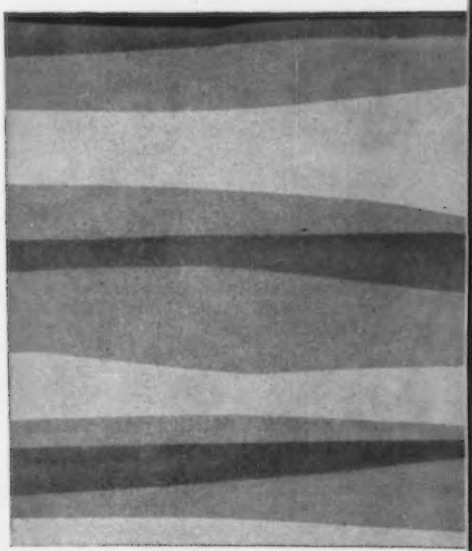

WHAT'S NEW IN PATENTS

OLIVER S. NORTH

Notice: Recently a Patent abstract service covering Russian and Japanese patents has been started by Derwent Information Service, of London, England. Subscription rates for these services are £40 or $120 per year, each. Details of the services, and information on Russian and Japanese patent procedures, may be obtained from Derwent Information Service, Rochdale House, 128 Theobalds Road, London W.C. 1, England.

U.S. PATENTS

Mining

Improved mechanism for taking samples of cuttings during the wet drilling of shot-holes in veins, rock, etc. Portions can be taken from the hole-flushing liquid without interrupting the drilling operation. T. H. Hagerman, C. O. Morfeldt and N. E. Svensjo, assigned to AB Separator. U.S. 2,973,820.

Metal and Mineral Processing

Froth flotation method for recovering uranium values from dolomitic rocks impregnated with uranium-bearing gilsonite, grahamite, wurtzilite, or like asphaltites. P. E. McGarry, assigned to International Minerals & Chemical Corp. U.S. 2,973,-864.

In the separation of mixed pentachlorides of columbium and tantalum, the mixture is reacted with potassium chloride or potassium fluoride, thereby selectively forming a double salt of tantalum that can be effectively separated to leave a columbium-enriched fraction. W. Scheller, assigned to Ciba Ltd. U.S. 2,974,007.

Process for producing high-purity beryllium oxide and beryllium hydroxide from beryl ore. Purification is accomplished by treating the aqueous beryllium salt solution with zinc hydroxide in the presence of a compound of fluorine at a pH of about 8. P. Riabovol, assigned to Pechiney, Compagnie de Produits Chimiques et Electrometallurgiques. U.S. 2,974,011.

In the preparation of high-purity beryllium oxide, beryllium hydroxide is reacted with molten oxalic acid, and the reaction mass leached with water. The leach solution is filtered off and cooled, and the crystallized beryllium oxalate separated and pyrolyzed. R. Cooperstein and G. R. Anderson, assigned to U.S. Atomic Energy Commission. U.S. 2,974,-012.

Process for treating ilmenite, carnotite, tungsten-iron, and similar ores with sodium hydroxide or other anhydrous alkali-metal hydroxide at a temperature high enough to solubilize one of the component metals, and leaching the reaction mass to recover the solubilized metal oxide. H. H. Hoekje and R. A. Kearley, assigned to Columbia-Southern Chemical Corp. U.S. 2,974,014.

Mr. North is patent consultant, Washington, D.C.

In the drum balling of iron-oxide ore concentrates, an improved cutter-bar assembly is provided for controlling the thickness of the concentrate layer adhering to the drum surface and for maintaining a suitable surface on the layer. E. R. Makela, assigned to Reserve Mining Co. U.S. 2,974,358.

In the beneficiation of spodumene ore, the undecrepitated ore is ground to about 50- to 60-mesh and subjected to flotation to eliminate slimes. The mineral concentrate is then further ground to minus-40-micron size, which can be efficiently treated, e.g. by digestion in sulphuric acid, for recovery of lithium values. E. J. Martin and P. E. Landolt, assigned to Basic Atomics Inc. U.S. 2,974,884.

In a gyratory apparatus crushing taconite or other hard ores, the upper mantle has a yieldable insert, thereby permitting the upper mantle section to more readily follow and maintain contact with the lower mantle section. R. W. Anderson and C. F. Kamrud, assigned to Reserve Mining Co. U.S. 2,974,889.

In the filtration dewatering of slurries or pulps of metal-bearing ore concentrates, such as chalcopyrite, pentlandite, pyrrhotite, hematite and the like, a small amount of a tertiary amino alkyl ester of a fatty acid is added to the pulp. A friable filter cake that is free from surface moisture is obtained. M. D. Head, assigned to International Nickel Co., Inc. U.S. 2,975,-123.

Copies of U.S. patents can be purchased at 25c each from Commissioner of Patents, Washington 25, D.C.

In the flocculation of fine mineral particles, a small amount of a tertiary or quaternary amino alkyl ether of starch is added to the pulp. Cited examples show successful flocculation of (1) metal-containing fines such as zircon, wolframite, galena, chromite, and gold ore, and (2) nonmetallic such as clays, phosphate rock, barite, and marl. C. G. Caldwell, O. B. Wurzburg and S. C. Sun, assigned to National Starch & Chemical Corp. U.S. 2,975,124.

In the froth flotation of columbium minerals such as pyrochlore and niocalite from gangue materials, a small amount of catechol is added to the mineral pulp along with the usual 8-quinolinol or aliphatic diamine-monoamine mixture, and the pulp subjected to standard flotation procedures to float the columbium mineral. C. H. G. Bushell and H. E. Jackson, assigned to Nova Beaucage Mines Ltd. U.S. 2,975,895.

Direct and inexpensive method for magnetically separating nonmagnetic particles from a mixture thereof with finely divided ferromagnetic particles. Examples are given illustrating recovery of a titanium ore concentrate that is substantially free from metallic iron impurities. C. Presgrave, assigned to G. & W. H. Corson, Inc. U.S. 2,975,897.

In the production of improved taconite-concentrate agglomerates, the binder used consists of gelatinized corn starch and a mixture of swelling and nonswelling clays, e.g. ball clay or a mixture of swelling bentonite or hectorite with kaolin or attapulgite. W. G. Ekdahl, assigned to Johns-Manville Corp. U.S. 2,976,162.

CANADIAN PATENTS

Exploration

Method and apparatus for aerial prospecting for uranium ores or other radioactive minerals that emit gamma rays. A large area is photographed concurrently with determination of radiation from two or more small areas in the large area, and the responses are converted to a visual intensity record. Several independent detector units can be operated together advantageously to produce a filmed mosaic radiation intensity record. C. F. Teichmann and C. G. Ludeman, assigned to Texaco Development Corp. Canadian 614,371. Feb. 14, 1961.

Mining

Gravity-type cam-controlled latch mechanism for ensuring positive engagement of the car and the coupling head of a railway ore-car-dumping apparatus. E. J. Schnaitter and B. D. Mull, assigned to Erie Mining Co. Canadian 614,733. Feb. 14, 1961.

Metal and Mineral Processing

In the balling of ore concentrates, moist ore is given a preliminary compression treatment by pressing it onto a moving support surface. The pressed material is crumbled, and the crumbled pieces moved onto a nodulizing cup. O. Rolfsen. Feb. 21, 1961. Canadian 614,792.

Design for a high-capacity dry magnetic separator for upgrading low-grade magnetic iron-oxide ores, e.g. hematite and ilmenite. P. E. Cavanagh, assigned to Ontario Research Foundation. Feb. 28, 1961. Canadian 615,545.

Copies of Canadian patents can be obtained by writing to Commissioner of Patents, Patent & Copyright Office, No. 8 Bldg., Carling Ave., Ottawa.

In the fluidization of aqueous suspensions of ground ore comprising a wide range of particle sizes, a small amount of a water-soluble polyelectrolyte, e.g. polyacrylamide, is added to the suspension. Examples cited show application of this invention in the acid-leaching of gold, uranium, nickel-cobalt, and manganese ores. R. B. Booth, assigned to American Cyanamid Co. Mar. 7, 1961. Canadian 615,987.

Improved chain hammer mill for use in the breaking of crude phosphate rock or other ores that tend to stick and harden in the mill. W. J. Sackett, assigned to A. J. Sackett & Sons Co. Mar. 7, 1961. Canadian 616,032.

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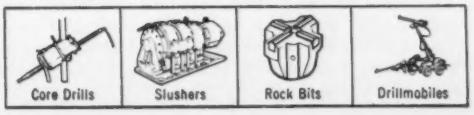
EQUIPMENT FOR MINING... FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

PERSONALS

John M. Kelly, of Roswell, N.M., has been appointed by President John F. Kennedy to be Assistant Secretary of the Interior for Mineral Resources.

A native of Chelsea, Mass., Kelly is a mining and petroleum engineer. As assistant secretary, he will discharge the duties of Secretary Udall in the field of natural resource development. He will also be responsible for the activities of the Bureau of Mines, the Geological Survey, the Oil Import Administration, the Office of Mineral Exploration, the Office of Minerals Mobilization, the Office of Coal Research, the Office of Oil and Gas, and the Office of Geography.

Kelly has been active in the field of petroleum conservation, and at the time of his appointment, he was the president of his own oil-producing firm in New Mexico. He is a graduate of the New Mexico School of Mines with degrees in mining engineering and petroleum engineering.

George F. McKereghan, former superintendent of the Calumet and Hecla uranium mine near Grants, N. M., will go to Liberia, Africa, as chief engineer in the development of a new open pit mine located in the Mano River district by Mine Management Associated Ltd., agents for National Iron Ore Co. Ltd. of Monrovia, Liberia. McKereghan had been employed in copper production work for Calumet and Hecla in Ahmeek, Mich. Until he transferred to Michigan, McKereghan was one of the pioneers in underground mining of uranium ore in the Ambrosio Lake area. He developed C&H's Marquez mine and brought it into production.

Frank C. Senior has been elected vice president in charge of operations for Strategic Metals Corp. He has been general manager of the company's SUMAC metallurgical plant at Niagara Falls, Ontario, since 1958.

Senior

Prior to joining Strategic Metals, Senior had been director of development of the engineering and construction division of the Koppers Co., which he joined in 1946. He also served Koppers as general manager of the metallurgical section, and, while assigned to the Chilean steel plant, as project manager of Huachipato Steel, near Concepcion. Later he went to Colombia for the Faz de Rio steel plant.

Until 1946, he had worked at Bethlehem Steel Co. in operations, research and as assistant chief engineer.

In 1950, he formed his own engineering company, and in 1951 he became president of Herman A. Brassert Co., an engineering firm. Senior built several large ore-beneficiation plants in the southern United States, as well as blast furnaces in Ohio, Ala. and Germany.

D. A. SLOAN, DIRECTOR of the Management and Productivity course, and senior partner of Urwick, Currie Ltd., brings a slide rule into play during a discussion of planning. Seated, left to right, are **R. E. Barrett,** Eldorado Mining; **W. R. Cooling,** Asbestos Corp.; **W. D. Jamieson,** Quemont, and **J. R. Smith,** Giant Yellowknife.

Sixteen mine executives from various parts of the U.S. and Canada recently completed a two-week management course covering all phases of the industry. Organized by Urwick, Currie Ltd., Toronto management consultants, the course was designed to help in the executive development of those with the capacity to accept more responsibility in mine management, and was designed for operating executives from mine, mill, plant and office, and senior supervisors and staff.

The two weeks, which included sessions in evenings and on Saturdays, were crowded with lectures, case studies and report assignments. Demonstrations of equipment and the use of films and tape recordings helped illustrate actual problems encountered in the field. Planning and presentations were handled by 12 practicing Urwick, Currie consultants.

D. A. Sloan, senior partner, and a graduate engineer who held supervisory positions in a number of mines before joining the company, directed the course. Urwick Currie expects to hold similar seminars in the future, possibly giving three or four such management courses each year.

Subjects covered included: scientific management; organization planning and development; cost and income planning and control; labor cost control; work studies; work planning and control; and industrial engineering organization.

Earle H. Miller, resident manager of United States Borax and Chemical Co., Carlsbad, was elected president of the New Mexico Mining Assn., succeeding **E. A. Slover,** general manager of the Chino Mines Division of Kennecott Copper Corp. **L. W. Swent,** general manager, Homestake-Sapin Partners, Grants, N.M., was elected first vice president, succeeding Miller. Swent was succeeded by **J. W. Faust,** general manager, Peru Mining Co., Hanover, N.M., who was elected second vice president of the association.

Frank A. Ayer, consulting mining engineer, has moved his office to 1370 Roosevelt Avenue, Pelham, New York.

Lawrence B. Wright, for the past 6 years chief of exploration for the Southern Pacific Company where he directed a mineral survey covering some 14-million acres, has resigned to establish his own consulting office in San Francisco.

Michael S. Reford has been named chief geophysicist for the Aero Service Group.

Reford

He joined Canadian Aero Service Ltd. five years ago to direct survey planning and operations and the interpretation of airborne geophysical data. Presently, he is engaged in the planning and technical direction of airborne geophysical survey programs in Australia, Egypt, Morrocco, Uganda, Chile, Canada and the U.S.

Reford had previously spent five years with Mobil Oil of Canada Ltd. supervising gravity, magnetic and seismic surveys, and finally being placed in charge of its geophysical operations in Saskatchewan.

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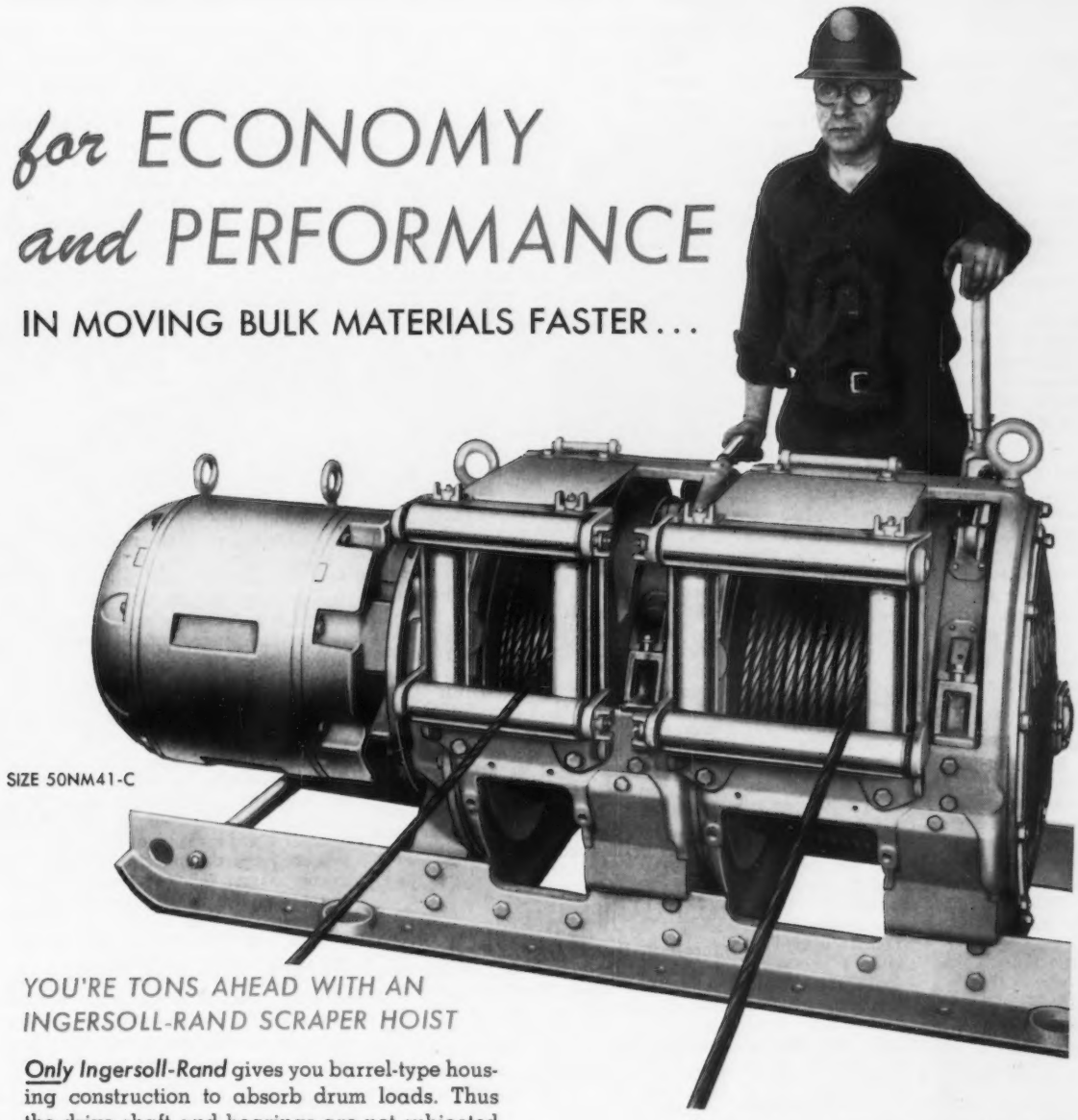

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Planned Annual Retooling increases output per man

Earl S. Mollard has been named vice president, mining operations, The Hanna Mining Co., and general manager of mines, The M. A. Hanna Co. **Emmons Coleman,** who has been manager of the Hanna Nickel Smelting Co. since 1953, will become general manager of Oregon operations. Prior to joining Hanna, Coleman was general manager of Bradley Mining Co. at Stibnite, Idaho.

Mollard joined the Butler Brothers organization in 1923 and was manager of mines for that company when it became affiliated with Hanna in 1948. From 1948 to 1953, he was general manager of Minnesota mining operations. In 1953, he became general manager of Oregon operations of The Hanna Mining Co. and the Hanna Nickel Smelting Co.

Ted Bush, who was deputy Idaho state mine inspector from 1950 to 1958, has joined the staff of the Bunker Hill Co. at Kellogg as a safety department assistant in charge of the enlarged safety program set up by Bunker Hill under its five-year labor agreement with the Northwest Metal Workers Union.

Lester F. Bishop, chief research engineer, mining research department, and **Wallace A. O'Brien,** Butte mines geologist for the Anaconda Co., retired April 1.

Both are natives of Butte and graduates of the Montana School of Mines. Both have been honored with professional degrees from the School of Mines in recognition of their achievements in their fields. Each started his career in the mining industry over 40 years ago.

Bishop developed the modern "bunch" blasting method in the Butte mines. O'Brien is credited with a geological study which led to the discovery of a large ore body and the revival of the St. Lawrence mine for a period of several years.

Bishop

Bishop was graduated from Butte High School in 1917, and went to work at the Douglas mine in Idaho for a year. He worked the summer of 1918 at the Climax mine near Philipsburg, and then enrolled at the University of Washington. He transferred to the Montana School of Mines in 1919, and was graduated in 1922. He then worked at the Nettie and Emma mines until 1925 as sampler and shift boss, advancing to safety engineer and assistant foreman of the Emma, and later to research. From 1934 to 1950, he was general foreman of production and training. In 1958, he was promoted from research engineer to chief engineer of the mining research department.

Bishop was actively identified with many of Anaconda's research and training projects and for several years, directed supervisors' training schools and trainee programs for the company in Butte. He is the author of numerous papers and articles on mining, research and training. During World War II he served as a panel consultant for the Training Within Industry Division of the War Manpower Commission. He is a member of the American Institute of Mining, Metallurgical and Petroleum Engineers, and the Montana Society of Engineers.

O'Brien, who attended schools in Roseburg, Ore., and Butte, was graduated from the Montana School of Mines in 1923. He started work as a miner in 1920 while still attending college. He became a sampler in 1923, transferred to the mining engineering department as an assistant engineer in 1925, and to the geological department in 1928. He was promoted to Butte mines geologist in 1958.

O'Brien

O'Brien participated in a number of important geological projects and made early studies of the block-caving and open pit mining possibilities in Butte. The School of Mines awarded him the professional degree of geological engineer in 1959. He is a past president of the Montana School of Mines Alumni Assn., and a member of the American Institute of Mining, Metallurgical and Petroleum Engineers, and the Montana Society of Engineers.

OBITUARIES

Ingolf E. Serigstad, 55, former general member of the North Butte Mining Co., Butte, died March 17 in Downey, Calif.

Serigstad came to Butte in 1936 and worked as a sampler for the Anaconda Co. He then became a shift boss for the North Butte Mining Co., and later, manager. He left Butte in 1955 to enter business in Downey.

Sidney Rolle, 77, died March 25 as a result of an auto accident while he and his wife were touring France.

Rolle, who made his home in Princeton, N.J., had been associated with American Metal Climax, Inc., for 44 years before he retired in 1954. Since that time, he had been active as an independent consulting metallurgical engineer.

Herbert Spencer Cohen, 59, vice president of American Metal Climax, Inc. died March 27 in Brooklyn Jewish Hospital where he had been recuperating from a recent operation. He had been vice president in charge of finance for Amax since 1957.

Starting as an office boy with L. Vogelstein & Co. in 1915, he advanced in the company and in 1927, following Vogelstein's merger in 1920 with American Metal Co., Ltd., he became assistant to the treasurer of American Metal. In 1948 he was named assistant treasurer, controller in 1949, and vice-president and controller in 1953.

Cohen was a director of United States Metals Refining Co., and various other subsidiaries of Amax. He was a member of the Mining and Metallurgical Society of America, the Mining Club, the Harvard Advanced Management Assn., and others.

Alfred J. Cayia, a leading figure of the iron ore and limestone industries of the Great Lakes district for many years, died April 2, at Manistique, Mich. He had retired in 1957 as president of Inland Steel Co.'s limestone division, Inland Lime and Stone Co., of Manistique, and of Caland Ore Co., Ltd., the steel company's subsidiary developing its spectacular iron ore property at Steep Rock Lake, Ontario.

Cayia started his long career in 1914 on graduation from the University of Michigan, becoming an engineer for M. A. Hanna Co., later moving to the company's Cleveland headquarters as a consulting engineer, and then back to the northern ore country as superintendent of the Hanna company's Wakefield mine in Wakefield, Mich.

In 1928, Inland induced him to join its organization to develop its limestone quarry and the preparation plant and harbor at what is now Port Inland, Mich., near Manistique. Cayia is credited with developing Inland's limestone division into one of the outstanding properties of its kind in the United States. He was manager of the company's iron ore properties in the period of active expansion that followed World War II, and he initiated the development of the Caland iron ore mine in Steep Rock Lake, Ontario, which involved one of the biggest dredging jobs in history.

Many distinctions came to Cayia in his profession and for his service to civic and philanthropic organizations in his home community and Upper Michigan. In 1952 he was awarded the Michigan Economic Development Commission Distinguished Service Award and the Manistique Rotary Club Distinguished Service Award, and in 1953 the University of Michigan College of Engineering Citation as distinguished alumnus.

He was elected councilman and mayor of Manistique in 1930. Schoolcraft Memorial Hospital was built under his leadership as chairman of the board of trustees. He also served his church in the same capacity. He was a director of the University of Michigan Development Council, and had also served as a member of the Michigan State Economic Development Commission and the commission's Upper Peninsula Industrial Advisory Committee.

A. L. Nash, Sr., 71, died March 13 at Concord, N.C., following an illness of four months. During his 30 years of participation in the mineral development program of North Carolina, he had served as a mine manager, operator and developer of numerous mining enterprises and ventures.

REPORT FROM WESTERN MATERIALS INC., PAMPA, TEXAS

"Our new 944 Traxcavator loads and levels nine 18-yd. trucks an hour

It gets its bucket full easier than other machines, is faster and handles better. Has plenty of reach for big trucks, too."

THAT'S the word on the 944 from Craig Childers, Western's Plant Superintendent. And here's what the operator thinks about it, "I like the way it handles. It's really a fast-loading machine; and it has good balance and visibility. The idea of having the lift arms out front where you don't sit between them is great."

You can choose from three sizes in the new Traxcavator line. The 944 packs 105 HP and a 2 cu. yd. standard bucket—the big 966 at 140 HP carries a 2¾ cu. yd. standard bucket—and the 80 HP 922 has a 1¼ yd. bucket. All three mount a variety of buckets and attachments for handling various materials. And all three have what it takes to move more tons per hour and stay on the job month after month with far less maintenance.

Your Caterpillar Dealer has all the facts. Ask him to set up a Traxcavator demonstration on your job, and get a firsthand look at all the new ideas that are built into these machines. It'll be a real eye-opener.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

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TRAXCAVATORS ARE MAKING OTHER LOADERS OBSOLETE

Here's how the 922, 944 and 966 are built to do a better job for you.

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CAT POWER SHIFT TRANSMISSION—gives instant shifting, forward and reverse, 1st and 2nd speeds. High and low range selector also provides two-wheel drive for roading, four-wheel drive for power and traction in work cycles.

OPERATOR SAFETY—Lift arms and cylinders are forward of the operator and cockpit. Visibility is excellent and access is easy... up three wide steps.

LONG REACH—With the lift arms up front, the reach at dumping height of the new Traxcavators is impressive: 57″ on the 966, 51″ on the 944 and 41″ on the 922.

OPERATOR CONVENIENCES—Bucket controls have automatic positioners to speed every cycle; machine controls are all power boosted for easy operation. Dual brakes give operator choice of braking with or without transmission engaged.

FULL LINE OF ATTACHMENTS—Special material buckets, side dump buckets, forks, cabs, etc.

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Small Mines (*Continued*)

5. Helping the small miner through National Mining Enterprise technical and financial aid.

6. Completing the mining industry cycle: from the mine to flotation mill, smelter and electrolytic refinery which is scheduled to be built at Ventanas.

Houston Engineer Cites Costa Rican Iron Ore Find

A NEW iron range has been discovered on the west coast of Costa Rica by A. W. Dugan, a Houston, Tex., engineer; geologists and the Costa Rican Bureau of Mines have confirmed the discovery. The largest series of deposits scattered over some 80 square miles, are in Guanacaste Province, within five miles of the Pacific and near suitable shipping and loading points.

Claims on the area have been granted to International Iron of Costa Rica, now conducting exploration, evaluation and development planning of the potential deposits.

California Asbestos Mine Sets Reserves at 17-Million

JEFFERSON LAKE Asbestos Corp.'s asbestos mine, located at Copperolis, Calveras County, Calif., contains approximately 17-million tons of cross-fibre chrysotile asbestos-bearing rock, according to the estimates of Gordon H. Gibbs of Toronto, the company's consultant. In addition to the original 480-acre purchase, Jefferson Lake has acquired 12 continuous claims and an 80-acre mill site.

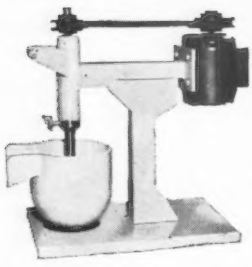
The processing mill—with an expected capacity of 2500 tpd—should be nearly completed by March 1962.

Montana Mine Claims A Major Gold Strike

A NEW gold strike has been found near Townsend, Broadwater County, Mont., beyond the end of an old, unused 1700-ft tunnel first driven in 1906. According to Paul I. Raber, president and general manager of the Northern Milling Co., the 3½-4 ft vein was discovered April 8, about 300 ft below the present operations in Northern's Marietta mine.

Australian Symposium Set

THE Broken Hill Branch of the Australasian Institute of Mining and Metallurgy will hold a Symposium on Diamond Drilling on Aug. 21-25, 1961, at Broken Hill, New South Wales. Emphasis will be on exploratory diamond drilling; the program has the support of the Broken Hill Mining Companies and the Council of the Institute.



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What's more, when you buy a Mack B Model you get Undivided Responsibility. Undivided because Mack practices Balanced Design, an exclusive Mack engineering concept assuring that every major component in a Mack is built by Mack to operate with every other as a strong, sweet-running unit.

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So remember, no matter what hauling job you have in mind, there's a Mack B Model that will do it better and for less over-all cost. See your Mack branch or distributor for actual performance data. Mack Trucks, Inc., Plainfield, New Jersey. Mack Trucks of Canada, Ltd., Toronto, Ontario.

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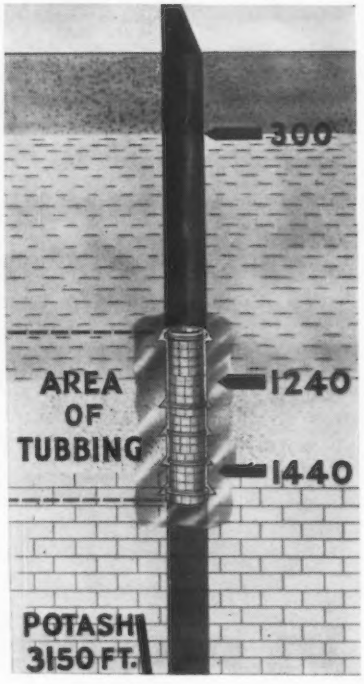
INTERNATIONAL MINERALS & CHEMICAL CORP. of Canada's pilot processing plant for the Esterhazy, Sask., potash mine (E&MJ, December 1960, p 130) is now virtually complete. The unit will handle 420,000 tons of potash a year, and IM&CC hopes to more than double capacity with construction of an addition this summer.

IM&CC Finishes Tubbing; Armour-PPG Coming In

INTERNATIONAL MINERALS & Chemical Corp. has completed tubbing the water-bearing Blairmore formation and has awarded contracts to Patrick Harrison & Co., to lower the mine shaft to the potash beds, and to Cementation Co., for the grouting work.

Purpose of the tubbing operation shown in this cross-section of IM&CC's mine shaft at Esterhazy is prevention of seepage from the 200 ft Blairmore stratum, composed of porous, water-bearing sand and clay layers. The potash beds are located at 3100 ft, but IM&CC expects no unusual drilling problems with the intervening 1600 ft of limestone.

Meanwhile, in Moosejaw, Sask., Armour Agricultural Chemical Co. and Pittsburgh Plate Glass Co. will attempt solution mining of potash in a joint $1-million experimental plan. Exploratory drilling—begun early in March—shows a potential 70 ft stratum at 5100 ft. To reach this deposit, water will be pumped down the shaft, dissolving the potash which is recovered from the solution above ground. Armour and Pittsburgh expect to form a joint Canadian company for large-scale production of muriate of potash after successful completion of this pilot operation.



American Metal Climax Joins Tungsten Ventures

AMERICAN Metal Climax of New York has expanded into two new tungsten ventures: in Canada, with the Canadian Tungsten Mining Corp.; and stateside, where Amax has taken option on the Bradley Mining Co.'s old Ima properties, near Challis, Idaho.

North of the border, Amax's wholly-owned Canadian subsidiary, Northwest Amax Ltd., will lend financial help—along with Dome Mines and Ventures—to Canada Tungsten Mining, which plans a tungsten concentrator in the Flat River area of Northwest Territories, Canada.

The three firms will provide Tungsten Mining with $1-million in working capital until the debentures have been repaid and Canada Tungsten has generated a $1 million cash flow.

With this solid backing, Canada Tungsten has authorized the completion of the plant airport and the road from the mill site to the orebody. Open pit mining should get underway once the ore has been exposed. In addition, Tungsten hopes to receive prospecting permits covering a substantial area around the present claims, and plans a large scale exploration program this summer.

The opening up of this high-grade orebody in an inaccessible part of Canada is also credited to the Dept. of Northern Affairs and National Resources of Canada which will not only build an 80-mile development road from the Ross River Road to the Hyland River Valley but will also pay two-thirds the cost of 50 miles of access road to the mine site.

IN THE U.S.

ARIZONA

At Banner Mining Co.'s Palo Verde, the firm reported a 38% increase in tonnage of ore available to open pit mining. L. L. Travis, president of Banner, said in annual report that this open pit ore represented an extension of the orebody in the Mission project of American Smelting & Refining Co. As a result of core drilling, Banner officials said, "total indicated reserves of open pit type copper ore on Jan. 1, 1961 amounted to 58,231,848 tons, an increase for the year (1960) of over 15.5-million tons. Exploration drilling will continue in this area.

Mr. Travis said that within the next four years, Asarco's open cut "Mission Project" will have advanced pit limits to "the southeast boundary of Banner's Palo Verde property . . ."

The Patagonia area is enjoying the beginning of a long-awaited revival of mineral interest. A number of geologists of major mining companies are said to be investigating in the area and the following activities are under way:

W. D. Roper, of Safford, is driving a 1500-foot adit into Red Mountain, about 4 miles South of Patagonia, investigating known mineralized zones which can be seen on the surface. Good progress is being made, and the adit is now in over 150 ft.

Chas. A. Steen's Utex Exploration Co., of Moab, Utah, has been diamond-drilling in the Mineral Segregation of the Baca Float No. 3. Boyles Bros. were the contractors on this work.

Jackson L. Mershon, of Bristow, Okla., has purchased over 100 unpatented lode claims from the Coronado Mines Co., consisting of the Buena Vista and Four Metals groups and adjacent ground.

At the present time the U.S. Geological Survey is making a detailed Geological map of portions of the Patagonia Mountains. Frank Simons, whose headquarters is at the Little Outfit ranch, is the geologist doing the work.

Nash and McFarland, of Washington Camp and Patagonia, continue their operation of the Trench Mill, principally on lead-zinc-copper ores from the Flux Mine, but partially on custom ores. They employ over 40 men in this operation, and ship their concentrates by rail to the El Paso and Amarillo smelters.

Larry Drake and associates shipped a carload of copper-silver ore from the Montezuma mine near Salero.

LOOKING FOR HIGHER EFFICIENCY AND LONGER LIFE IN RIGHT ANGLE DRIVES?

Then take a closer look at Philadelphia Spiral Bevel Reducers. They'll give you an efficiency advantage of 5 to 50% over other types of right angle drives . . . depending upon ratios.

HIGH EFFICIENCY. With efficiencies of 95 to 98%, spiral bevel reducers will lower your power costs . . . reduce the cost of prime movers.

HEAVY DUTY. The bearings and shafting in Philadelphia Spiral Bevel Reducers are designed for 185% overload. Spiral Bevel Gears and Pinions are hardened after they are cut, then lapped to a mirror finish. Helical gearing in multiple reduction units is precision hobbed and shaved from through-hardened alloy steel. Result: greater load carrying capacity, longer life.

COOLER RUNNING. Compared to other types of right angle drives, Philadelphia Spiral Bevel Reducers run cooler. Separate cooling systems are not needed for most applications.

COMPLETE LINE. Philadelphia Gear offers the most comprehensive line of Spiral Bevel Reducers available — or we can build specially engineered units to meet any special requirement. Ratios from 1:1 to 238:1. Single, double or triple reductions in either vertical or horizontal types. Catalog SB-60 gives full selection data. Write on your company letterhead for your copy.

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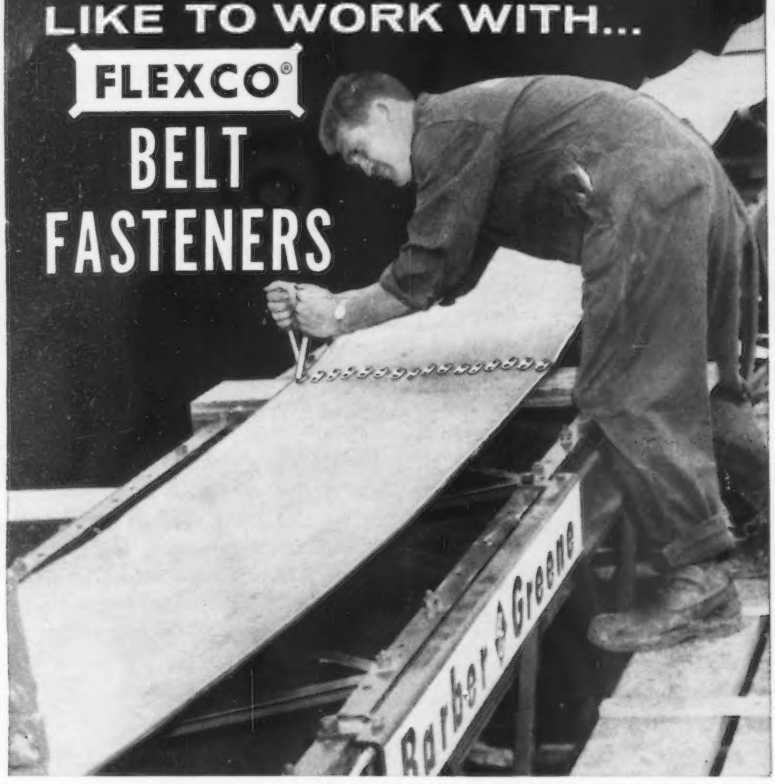
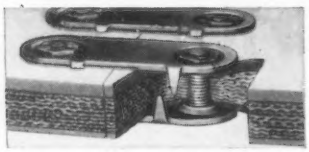


Lowell Lynde, Service Engr., Barber-Greene Co. completing the installation of a FLEXCO splice.



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He says, "I've spliced most of the belts our Chicago office has sold throughout Illinois and northern Indiana. FLEXCO fasteners have been used on all of them without any trouble. They are easy to install and hold up well regardless of the material conveyed."

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CALIFORNIA

Board of directors of Yuba Consolidated Industries, Inc. has elected J. Philip Murphy as company president, replacing John L. McGara who resigned. Murphy backers had threatened a proxy fight over leadership of Yuba if McGara would not give up the post.

Ben Tyrrell and Joe Nemie of Stockton are developing a high grade silica sand deposit near Rice. Drilling to date has blocked out more than 6-million tons.

IDAHO

Federal Resources Corp. of Salt Lake City will deepen its new three-compartment shaft in the Lake View mining district in anticipation of major increase of silver ore in St. Regis formation.

Ralph W. Neyman, Federal president, said the deepening of the shaft from the 1000 ft to the 2000 ft level will add an estimated 250,000 tons of ore running 20 oz of silver to the ton and 3% each of lead and zinc at the Conjecture mine.

Federal, said the veteran Coeur-d'Alene district miner, already has developed some 100,000 tons of high grade silver ore in exploration in the St. Regis transition zone at the 1000 ft level.

By deepening to the 2000 foot level and then drifting and cross-cutting through the St. Regis to the west, Federal also anticipates intersection of a major down-faulted zone in the St. Regis. This zone can not be penetrated from 1,000 foot level drift.

Cost of the current development plan is placed at around half a million dollars.

Based on the ore reserve developed, Federal will build at the Conjecture property either a 250 or a 500 tpd mill, Neyman said.

Work is being pushed on a new hoist building to house a new 1250 hp hoist scheduled for installation during the early summer at the property of the Lucky Friday Silver-Lead Mines company near Mullan. The building will be of reinforced concrete, 65 ft long, 40 ft wide and 35 ft high. The new hoist, ordered from the Nordberg Construction Co. of Wisconsin, will have a lifting capacity of 150 tph of ore from a depth of 2600 ft, scene of much of the mine's current production, and 90 tons from a depth of 5000 ft, which is figured as the ultimate depth of the company's operations.

The 1960 production of the Sunshine Mining Co. in Northern Idaho totaled 232,342 tons, averaging more than 27 oz of silver per ton, and with a gross value of $6.1-million, Robert M. Hardy, president, says in his annual report to stockholders. Estimated ore reserves at the year-end were 373,000 tons compared with 382,000 tons at the start of the year, Hardy said.

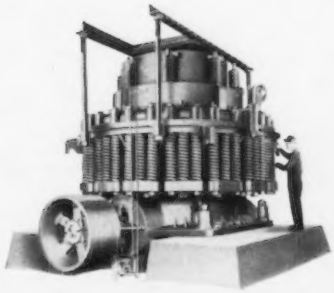
McFarland & Hullinger, Tooele mine contractors, have taken lease on the Polk-Shenon copper mine near Baker.

Dolomite

the "building blocks" of progress

When Nature adds magnesium to limestone, the result is *dolomite*. In the form of crushed aggregate, it is used for road building, in concrete dams and other engineered construction projects. As crystalline dolomite marble, it is used as ornamental building stone. And because of its magnesia content, it is widely used in making refractories for open-hearth furnaces and Bessemer converters. Found in massive beds throughout the world, dolomitic limestones are truly the building blocks of progress.

In processing this rock-mineral, Symons Cone Crushers have again maintained their leadership in high capacity, low-cost production of finely crushed product. *For in dolomite as in all important rock and ore crushing operations around the world,* Symons Cone Crushers are first choice of leading producers.



SYMONS® CONE CRUSHERS
. . . The machines that revolutionized crushing practice . . . **are built in a wide range of sizes, for capacities to over 1500 tons per hour. Write for descriptive literature.**

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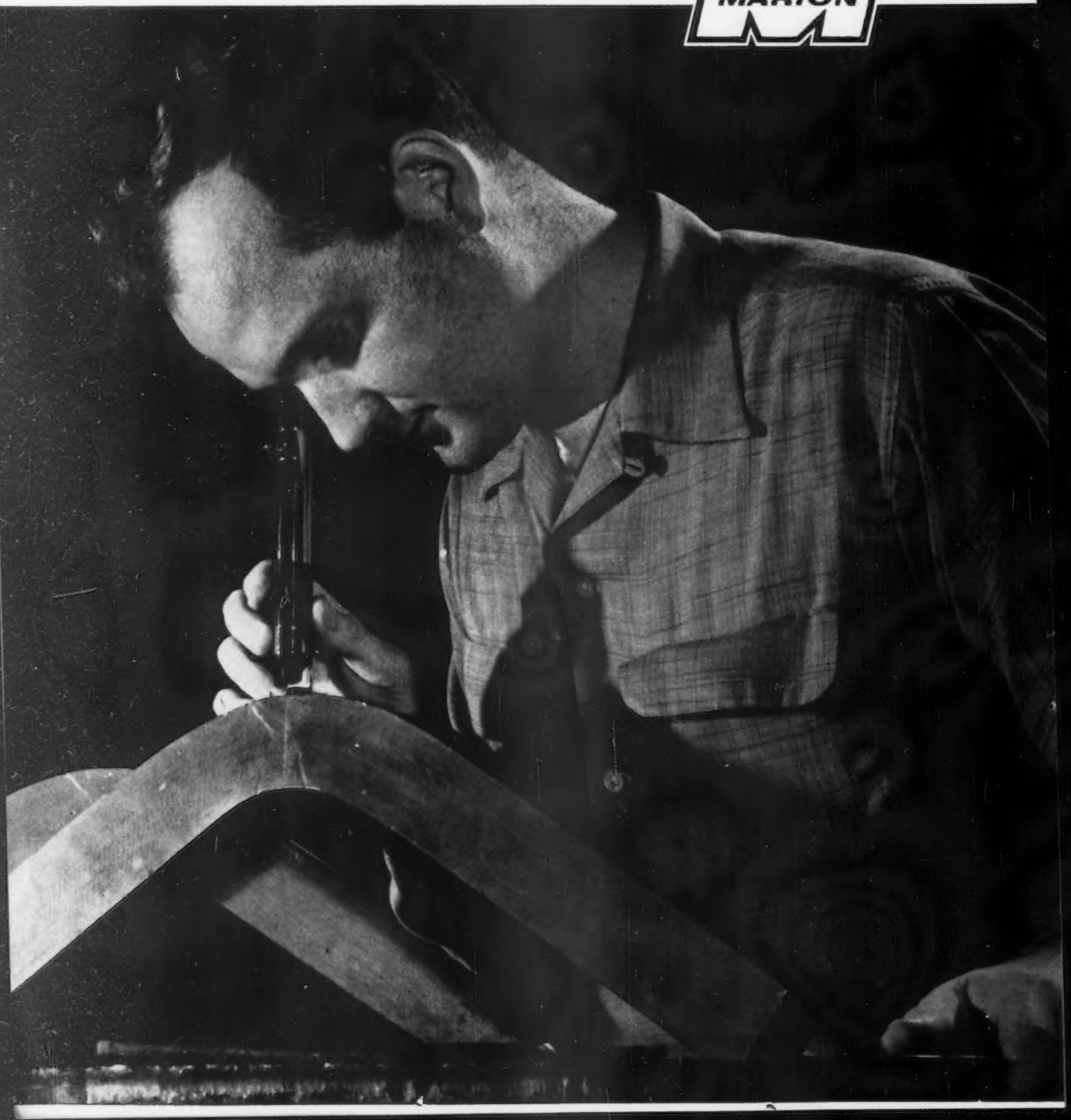
Strange things can happen to steels in the −50° temperatures encountered on the Iron Range. At such readings, ordinary steels can snap like brittle spaghetti. It's one of the big reasons why Marion uses high strength, high alloy steels at vital points throughout their intermediate size excavators. But, these new steels offer machine owners more than just excellent cold strength characteristics. For one thing, they're more resistant to fatigue and heavy shock loading. More important, their inherent strength permits lighter construction. That means your operator is lifting less dead weight...more payload. The man in the picture? Marion takes nothing for granted. He's performing one of dozens of quality check tests that every piece of steel undergoes, from the Marion laboratory to the final assembly station. The long way around? Perhaps. We're willing to let the profit figures for these Marions settle that one. Marion Power Shovel Company, Marion, Ohio. A Division of Universal Marion Corporation.

MARION



LOUISIANA

Production from the historic Belle Isle rock salt deposit is expected from Cargill, Inc., a farm products group, in 1962. Cargill will sink a shaft in the muddy ground near Morgan City and use refrigeration in 40-ft "takes" to sink the 1300-ft shaft and emplace concrete lining. Capacity production of 400,000 tons of crushed rock salt is foreseen by the company.

Belle Isle is a one-mile triangular island about 15 miles from Morgan City —some 100 miles west-southwest of New Orleans. It is one of five similar "salt islands" in this Gulf Coast area.

A 16-ft circular shaft will be sunk some 300 ft and sealed, watertight, into the salt itself. This will be accomplished by a treatment in which a vertical core of earth 40 ft in diameter is literally frozen by mechanical refrigeration, enabling the shaft to be dug into the otherwise muddy earth without collapse. Walls of the shaft will be lined with reinforced concrete as work progresses. The contract for the shaft and hoist system has been awarded to Winston Bros. Co., Minneapolis.

Underground mined areas for the entire operation will contain all of crushing, processing, screening and storage. Only a 400-tph hoist system will be housed above ground.

MICHIGAN

E. L. Joppa, Duluth, general manager of Pickands Mather & Co. Lake Superior area operations, announced the indefinite closing on March 16 of three underground mines on the Gogebic and Menominee ranges: the Peterson at Bessemer, which reopened on March 6 after a 39 day shut-down for repairs of a broken generator, and the Cary at Hurley, Wis., on the Gogebic. The Buck at Iron River, Menominee range, was the third.

Inland Steel Co. March 24 announced the resumption of full five day week schedules at four Upper Michigan iron mines starting April 1. The mines had been on a four day week since last September.

White Pine Copper Co.'s new 22 ft-dia circular shaft, which will be sunk to a depth of 2200 ft, will develop an orebody containing some 50-million tons of ore with 30 lb of copper per ton. An adjacent area, also owned by Copper Range, the parent company, reportedly contains another 50 million tons containing about the same percentage of copper.

MINNESOTA

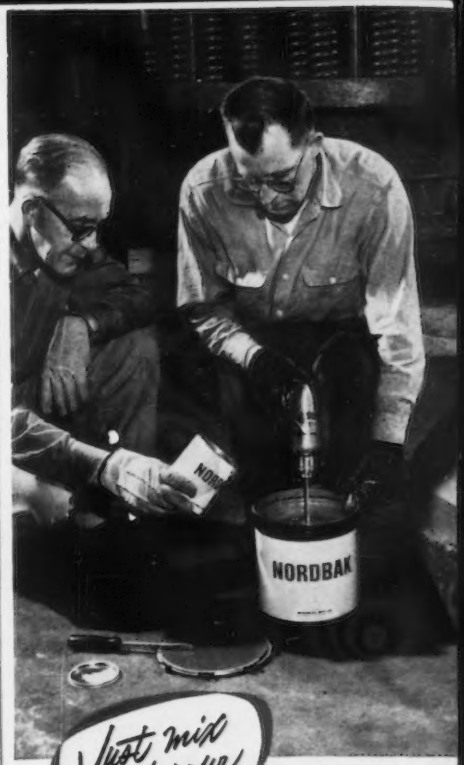
Jones & Laughlin's new low grade ore treatment plant at its Hill-Annex mine in Calumet is expected to be ready about June 1. The crude ore will come under the classification "semi-taconite." A 22ftx10ft drum will reduce the ore from 6½" to 28 mesh size, followed by spirals. A flotation process will be installed later. About 35 men will be employed at the plant.

C. F. Beukema, president of Oliver Iron Mining Div., announced March 2 that Oliver's Pioneer underground mine at Ely on the Vermilion range will construct a washing plant this year within the existing shaft headframe which will operate on a 12 months basis. Mr. Beukema credited the 1959 act of the legislature, which eliminated taxation on stockpiled ore, with helping to make such a plant economically possible. He said the new washing plant will be the first year round operation of its kind in Minnesota. It will consist of a crusher, classifier and spirals and will separate the fine ore from the coarse.

In March the M. A. Hanna Co.'s new 110ftx160ft semi-taconite plant at Cooley was visited by 150 state legislators and newsmen. The guests of the company were shown through the plant and also visited the Pierce mine at Hibbing. At a noon luncheon B. M. Andreas, mgr. of Minnesota mines, praised the legislature for passage of the semi-taconite bill in 1959. "This pilot plant would not have been built had it not been for this law," he said. "If this $2-million experiment results in a successful method to process semi-taconite into a product that can meet competition, a larger commercial facility will be built which will mean year round jobs, and will contribute greatly to the economy of the range as well as the state." Just how many persons would be employed in a commercial plant depends on its size; but the pilot plant operation alone will employ at least 43 men working the year round.

While Minnesota mines are facing diminishing high grade reserves, increased costs and a demand for higher grade iron ore, other states and countries are ready to supply the required grades at a price steel plants will pay. He said that Hanna's work on semi-taconite was started in 1934, but the process developed then was too costly.

S. E. Erickson, the company's director of beneficiation, explained the technical phases of the process. In general it consists of magnetizing the non-magnetic semi-taconite, which exists in large quantities on the western Mesabi range, in an 80 ton rotating Lurgi kiln after which it is subjected to the same process as regular taconite. Magnets separate the iron particles from the waste material, and the particles are formed into pellets or sinters. The crude semi-taconite runs about 32% in iron. The semi-taconite law eliminates the advalorem tax and substitutes a 5¢ per ton on agglomerated concentrates with 55% iron. It adds one tenth of a cent for each 1% that the product goes over 55%. If the concentrate is not agglomerated in Minnesota, the tax is raised to 10¢ a ton for a 55% iron content and increases one tenth of a cent for each percentage point above 55%. This special tax is in addition to the occupation and royalty taxes.



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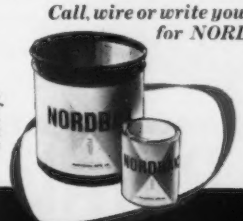
Tough, Resilient, Non-Metallic

Here it is! NORDBAK . . . the manganese backing you pour at "room temperature." You simply mix the contents of two cans together and pour!

Field tests and on-the-job experience show that NORDBAK really works! Because it's resilient and non-shrinking, it provides excellent backing. It's so tough that in a prolonged test the manganese wore through in spots, but NORDBAK remained uncracked. It's easily removed at changeout, too. You can store NORDBAK at your operations . . . get a supply to keep on hand, ready for the next time you replace liners.

Call, wire or write your order for NORDBAK!



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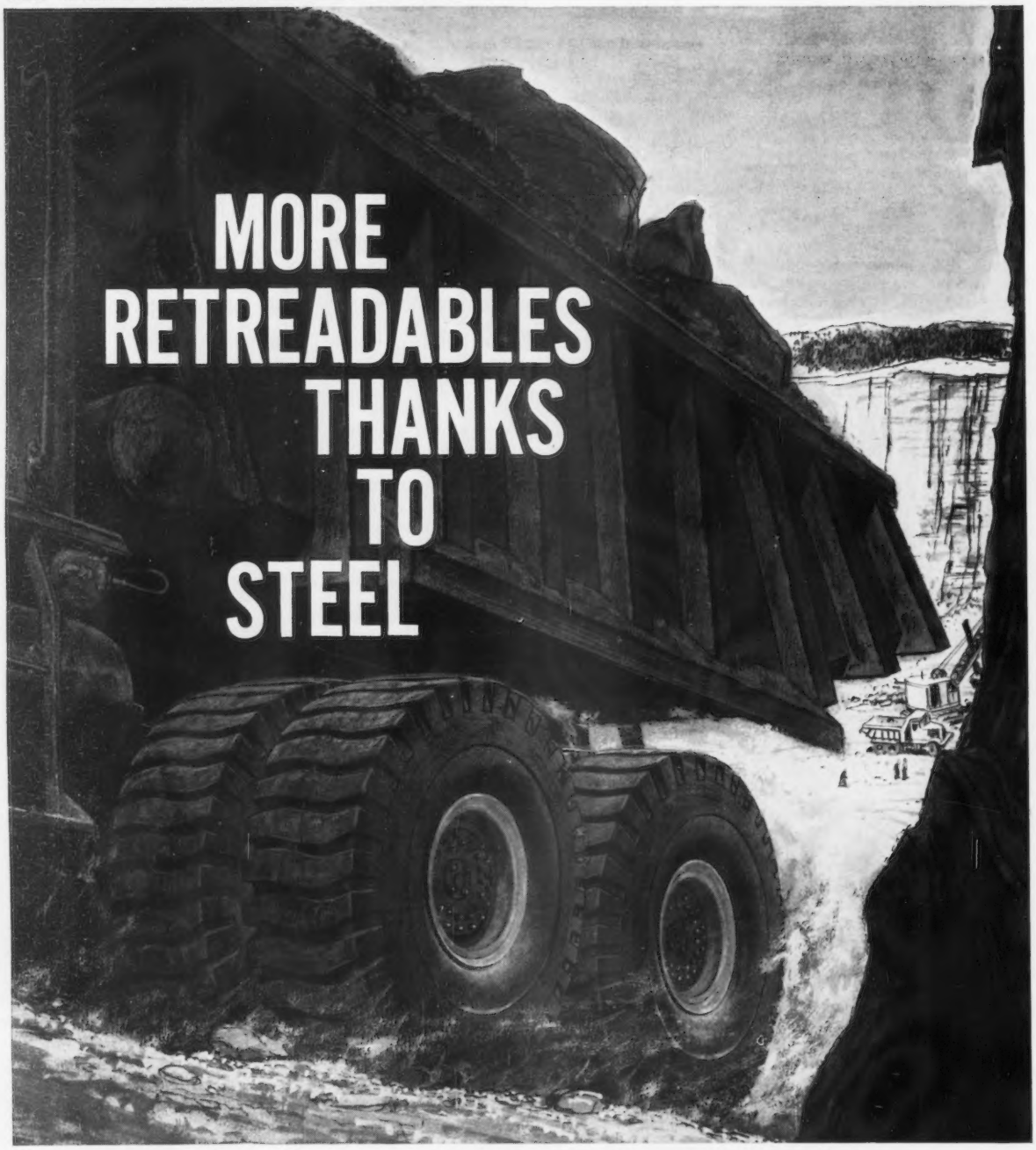
THE WORLD'S TOUGHEST OFF-ROAD TIRE



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MONTANA

The reopening of the Leonard Mine, Butte, late this year or early in 1962 has been announced by the Anaconda Company.

The mine has been shut down since June 1, 1958. Plans for its reactivation were announced March 21 by E. I. Renouard, vice president of the company.

An estimated 300 miners will be required to operate the Leonard when the planned production goal of 1000 tpd of ore is attained.

In addition, Renouard's statement included that studies are being made to determine if zinc production can be made possible in Butte at the current price of 11½ cents a pound. There is no mining in Butte of zinc or manganese because of the imbalance between productions costs and market prices.

Renouard said that the decision to reopen the Leonard means that the mine will be in operation at least two years sooner than had been planned under the deep-level mining program.

The Anaconda executive explained that ore to be mined in this project will be trammed on the existing 1600 and 2000-ft levels of the Kelley Mine for hoisting in the Kelley shaft. Service will be through the East Colusa and Leonard shafts.

The Leonard Mine was scheduled to go back into production with the deep-level mining program. This is the multi-million dollar, five-year project which the Anaconda Co. has undertaken in Butte to mine highgrade ore from deeper levels. The project will assure stope mining far into the future in Butte.

The Kelley mine No. 1 shaft is to be the central hoisting shaft for ore from deep levels of the Mountain Con, Steward, Leonard and, eventually the Belmont Mines. Haulageways are to be established from the Kelley to the Mountain Con and Steward on the 4400-level and to the Leonard on the 3900 level.

About 70 tpd of lead-silver-copper ore is being produced at the Nancy Lee mine near Superior. E. G. Smith, Osburn, Idaho, operator of the property, said 13 are employed at the mine and mill. He indicated that good ore has been developed on the new 150-ft shaft level. The lead-silver concentrates are being shipped to American Smelting and Refining Co's. smelter at East Helena.

Barite mining operations will be resumed on the Copper Mountain barite claims located five miles south of Troy, Montana. Recent exploration work on the surface has uncovered exceptional high grade chemical barite analyzing as follows:

Barite as $BaSO_4$	96.97%
Alumina & iron	0.36
Calcium	0.00
Silica	2.41

Six different barite veins varying in width from 2½ up to 7 ft have been exposed by surface exploration work. It is estimated that 75,000 tons of barite have been exposed by this work and that approximately 15,000 tons of this is suitable for chemical use. The remainder of specific gravity 4.2 to 4.3 will be sold as oil well weighting mud.

The property is jointly owned by Lendal and Donald Kotschevar of Sandpoint, Idaho. Exploration and mining operations are under the direction of Donald Kotschevar who is a mining engineer.

First part of the job of opening a tunnel at the New Departure silver mine near Dillon, has been completed, according to officials of Spokane National Mines, Inc., Spokane. Work was started in January under supervision of Cline Tedrow, mining engineer from Spokane. It included the driving of a 125 ft lateral to bypass a caved area. The project was needed to drain workings in an area formerly mined in 1900. Ore may be shipped to the company mill at Bannack at a rate of 125 tpd.

NEW MEXICO

Rare Metals Corporation of America has made new entry into drier sandstone area of its San Mateo uranium mine in he Grant's district.

The firm's decision on new mining approach results from collapse of upper portion of shaft in forepart of 1960 as a result of "unusually heavy precipitation".

Stearns-Roger Manufacturing Co. was awarded an engineering-construction contract for modernization of the Carlsbad, plant of Potash Co. of America. The project, estimated to cost $3.5-million, is scheduled for completion in mid-1962.

John W. Hall, Potash president, said the project is designed to give substantial improvement in processing efficiencies and permit mining of certain ores difficult to handle in the present plant. He said some ores had been by-passed because of a small magnesium content.

Two bills signed by Gov. Mechem will be important to the New Mexico mining industry.

HB 233 raises the severance tax on uranium from ½% to 1% of total value. The potash industry will be required to pay tax on 80% of their product value instead of the present 75%.

Hoisting, hauling and crushing deductions will be limited to 50% of the value of the ore produced in the uranium, potash and copper industries.

SB 340 relates to mine safety. It greatly increases the authority of the mine inspector in regards to safety regulations. The law also gives the mine inspector the power to obtain court injunctions against mine operators so as to correct dangerous mine conditions.

NEVADA

Goldfield Consolidated Mining Co. is installing a $28,000 water system at the Getchell mine in Humboldt County to supply water for the mine, townsite and

NORDBAK

It's Simple, Safe and Sure...

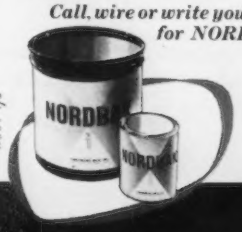
It had to happen...someone was bound to find a way to end the problems of backing maganese crusher parts with molten metal!

Now...you can do it with NORDBAK!

It's mixed at "room temperature" and poured right from a can into the crusher cavities. Gone is the need for special melting and pouring equipment...and gone are the hazards of pouring hot metal.

A trial order will prove, inexpensively, NORDBAK's many advantages.

Call, wire or write your order for NORDBAK!



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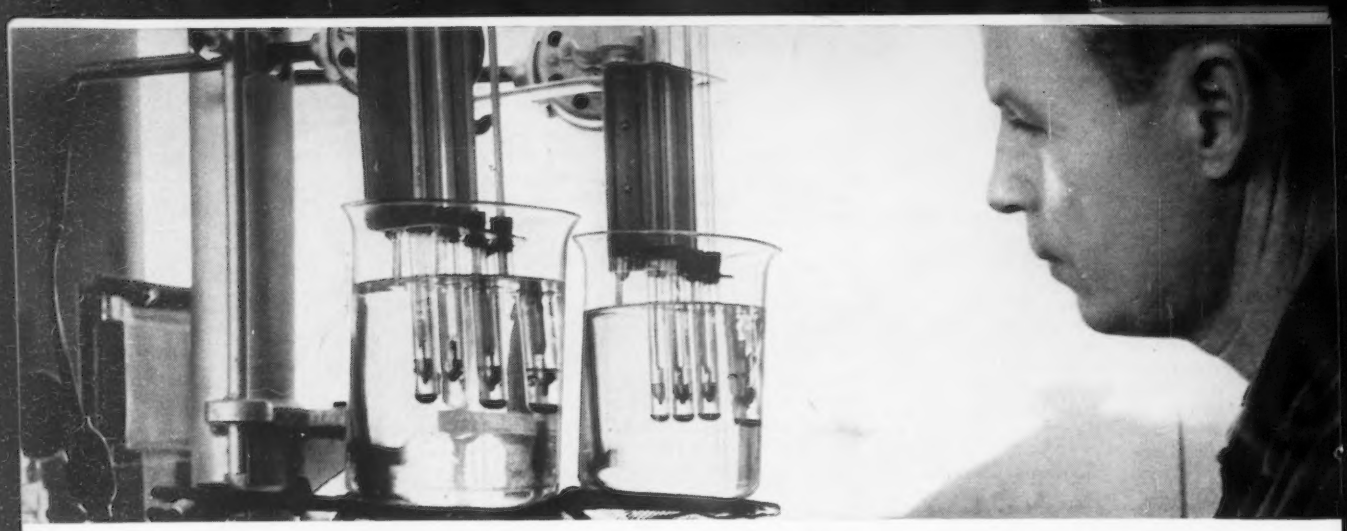

Dropping point test shows how greases react to heat. Beaker fluid has been heated to 390° F. All greases tested except Darina (second tube from left) have passed from solid to liquid state.

BULLETIN:

Shell reveals the remarkable new component in Darina Grease AX that helps it last up to 3 times longer than soap-base greases

Darina® Grease AX is made with Microgel*, the new thickening agent developed by Shell Research.

Severely tested for 18 months, Darina AX with Microgel proved its ability to resist washout, even in mud and slush—stay smooth and buttery at high temperatures—and reduce maintenance.

Read how this superior new multi-purpose grease can help solve your lubricating problems.

THERE IS no soap in Darina Grease AX. No soap to melt away—wash away—or dissolve away.

Instead of soap, Darina AX uses Microgel—a development of Shell Research.

What Microgel does

Because of Microgel, Darina AX has no melting point. It won't run out of bearings.

Even compared to soap-base greases, Darina AX provides significantly greater protection under adverse service conditions.

Resists washout

Mix water into Darina AX and the grease maintains its consistency. It shrugs off water—won't emulsify. For fleets that must operate in snow, slush, rain or mud—Darina AX is an ideal choice.

Longer lubrication life

Shell scientists tested Darina AX, under wet conditions, in a special device called an Oscillating Friction Machine.

Darina AX kept its lubricating qualities twice as long as a premium soda soap-base grease; 2½ times longer than a calcium-soap grease; 3 times longer than an aluminum-soap grease.

Results of field test

In a recent field test, 15 firms used Darina AX in chassis and wheel bearings of over 1000 vehicles. These buses, trucks and vans rolled up 30,097,000 chassis miles. The results:

1. Every company was pleased with the performance of Darina AX.
2. There wasn't one wheel bearing failure due to grease deficiency.
3. In many cases, re-lubrication schedules could be extended.

For details, see your Shell Representative. Or write: Shell Oil Company, 50 W. 50th St., N. Y. 20, N. Y.

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SHELL

A BULLETIN FROM SHELL
—where 1,997 scientists are helping to provide better products for industry

Nevada *(Continued)*

mill. At present the company has 25 men living at the Getchell townsite where they have been repairing the housing, remodeling the mill and installing the new water line. William H. Hisle, general manager, says present plans call for mining and milling gold ore during 1961.

Willis A. Swan, Goldfield president, has announced from his New York offices that his company plans to merge with Getchell Mine Inc. Directors of both companies have approved the merger, and the plan will be submitted to stockholders at annual meetings in April and May.

Ernest T. Carlow, of Battle Mountain, and Ezra Edwards, of Tenabo, have purchased the millable ore and other materials from the Silver Chief claims in Lander County. The sale was made by H. R. Rieck and Blain C. Hoalst, of Battle Mountain, owners of the property two miles northeast of the county seat. Values are chiefly in silver and lead, and Carlow and Edwards are hauling large tonnages to the new mill at Tenabo under a contract which calls for the delivery of 100,000 tons.

Lawrence Larmon, of Hannibal, Wis., and Earl C. Haffner, of Boise, Idaho, are moving in large amounts of machinery to their newly purchased mining claims nine miles west of Battle Mountain. They purchased the property from H. R. Rieck and George W. Dillon, of Battle Mountain, and have established a 25-ton pilot plant at the site. The ore contains tellurium, gold, silver, copper and lead.

Glen Sexton, of Garber, Calif., and Robert Graybar, of Reno, have completed a two-mile access road to their mining claim in the Humboldt mountains above Unionville in Pershing County. The two partners, who are president and secretary of Nutritional Additives Corp., have a D-8 Caterpillar bulldozer at the site and plan to mine trace elements.

The Fourbee-Kendyke Corp. shipped 51 tons of uranium ore to Vitro Chemical Co. in Utah during March. The ore was from a newly developed property in Lyon County which Ken Richter and Bud Frisbee, officers of the company, located in 1954. The two men are primarily engaged in aerial crop dusting, but seven years ago made a flight over Lyon County with detection equipment in search of uranium. Since that time $20,000 worth of development work has been done by the two partners. They expect the property to show good values in copper as well as in uranium.

Argentum Mining Co's. mill at Columbus Flat in Esmeralda County was in use for the last time during March. The largest precious metal mill in Nevada, it was first put into operation in the spring of 1960 following three years of construction that cost more than $1-million. After seven months the company, headed by E. S. Gates and Hap Halligan, was in financial trouble, and when mining and milling stopped last December unpaid wages to employees totalled $24,000.

Through arrangements with the Nevada labor commissioner, the company was permitted to mill stockpiled ore durin March provided that all money received from bullion shipments would be placed in escrow for distribution to the creditors. Trucks, cranes and other movable property belonging to Argentum was auctioned in March to settle other claims against the firm.

TENNESSEE

Tennessee Copper Co. has released its option on the Silver Hill mine located near Lexington, N.C. Tennessee Copper is reported to have spent nearly $250,-000 prospecting and developing the property. Apparently ore reserves could not be proved in sufficient amount to justify a mill.

American Zinc Co. of Tennessee recently purchased the mineral rights to two tracts of land near its Mascot zinc mine. Mrs. M. P. Woods sold the mineral rights on a 450-acre tract of land for $57,565. The mineral rights on a second 125-acre tract of land were bought from C. B. Thomas for $12,858.

Tennessee Corp. who bought Miami Copper Co. in June 1960, is embarking on another expansion. The program will include the construction of a large ammonia plant at East Tampa, Fla. The ammonia will be used to manufacture "Di-Mon", which is a high analysis fertilizer manufactured by Tennessee Corp.

Phosphate for the fertilizer is mined by the company in both Florida and Central Tennessee. Sulfuric acid, another component of the fertilizer, is produced at Tennessee Corp's. copper mines at Copperhill.

UTAH

Harrison International has won a multi-million dollar contract in sinking a 2800 ft shaft and completing 8000 ft of development work for Texas Gulf Sulphur Co. at Cane Creek.

Work on the shaft will start about June 1. Stearns-Roger Manufacturing Co., Denver, which has the surface plant contract, is now pouring the prestressed 160-ft concrete headframe and working on 70-ft shaft collar.

The 2800-ft shaft which Harrison International will sink through rock will be 22 ft wide, concrete-lined, and will have a divider.

This shaft is located in the gorge of the Colorado River, about 18 miles west of Moab. The shaft is some 3000-ft northeast of the Cane Creek potash orebody. Initially, Harrison International will drive two 3000 ft drifts through country rock to come in near the top of the principal potash bed.

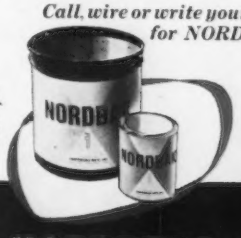
NORDBAK

It's the modern, effective way to back manganese

Non-metallic NORDBAK streamlines crushing operations of every kind. It's as easy to use out in the field as it is in the plant. You mix it and pour it right on the job...*wherever* your crusher is. No need for special melting or pouring equipment. Use it in gyratory crushers, cone crushers, grinding mills and other machinery where backing agents are required.

NORDBAK fills voids as narrow as ⅛" and is only ¼ the weight of other backing agents. Conveniently packaged, NORDBAK is *the one* modern, effective backing agent for manganese crusher parts!

Call, wire or write your order for NORDBAK!



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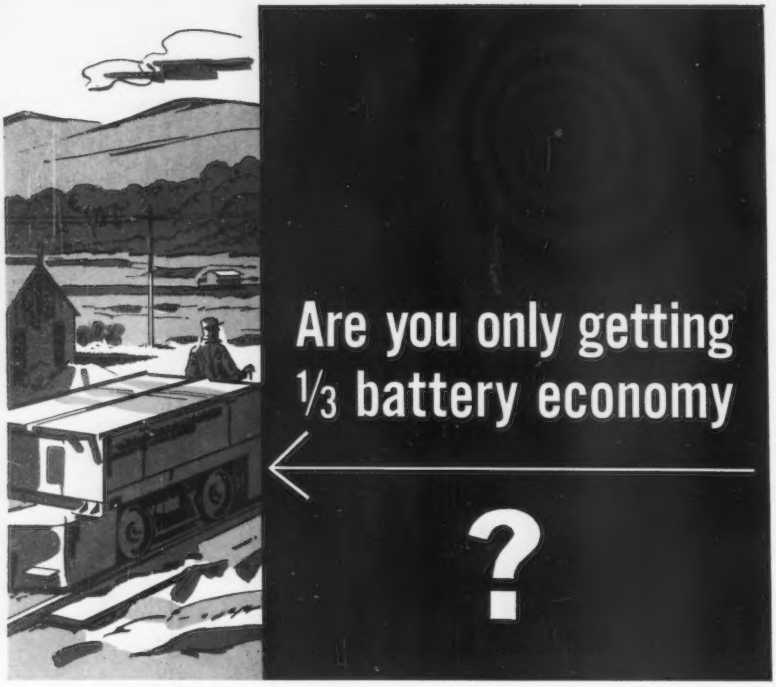


Do you buy batteries without considering the other two factors in battery economy: chargers and service? Exide has a plan to help you get all the economy possible from your mine locomotive batteries. It's the Exide power package—including batteries, chargers and service. It will save you money in the beginning and every year thereafter.

First, Exide will recommend the particular type and size battery that meets your needs exactly—at the lowest cost per year of use. Only Exide offers so broad a line: Exide-Ironclad for maximum capacity per cubic inch; Exide-Powerclad, the premium quality flat plate; and Exide nickel-iron-alkaline, the long life battery invented by Thomas A. Edison.

Second, Exide will provide the chargers, needed by your batteries to match their capacity, at lowest original cost and with efficiency to insure electric power economy.

Third, Exide factory-trained field men will help you keep both your batteries and chargers in top operating condition for long, dependable life. These men are specialists in Exide industrial battery equipment. Over 200 service specialists located coast to coast assure you of fast service when you need it.

Write for full details on the Exide power package. Exide Industrial Marketing Division, The Electric Storage Battery Company, Philadelphia 20, Pa.

Exide® INDUSTRIAL MARKETING DIVISION (ESB)
The Electric Storage Battery Company

Utah *(Continued)*

Mining by room and pillar method will be off of sloping cross cuts and a sloped extension of these drifts each 75 ft apart. These main drifts will be 16 ft wide and 8 ft high.

Potash ore will be moved to the skip pocket at 2750 ft level in the shaft by electrically driven, rubberized conveyor belts.

Initial production rate will be 800 tpd of ore. Ultimately, TGS may be producing 12,000 tpd of ore, equal to 1.7-million tons of muriate of potash annually.

A further increase to 16,000 tpd of ore is a possibility. Completion of the project is set for late 1962.

An extended development program below the water level at the Cardiff mine in Utah's Alta district is proposed in a joint venture of Grand Deposit Mining Co. and J. J. Beeson and his wife, Desdemona, Salt Lake geologists.

Charles A. Steen, Reno, Nev., president of Grand Deposit, said his firm would share on a 50-50 net profits basis with the Beesons, with Cardiff Industries receiving a sliding scale royalty based on ore grade.

Utex Exploration Co., also headed by Mr. Steen, will stand behind Grand Deposit in purchase of equipment and supplies, he said. Utex controls more than 51% of Grand Deposit stock.

Mr. Beeson, who has been active in the district 18 miles east of Salt Lake City for 35 years, will direct the project. He said that "what we are doing is taking over the operations and the mining of the Cardiff Extension orebody with the expectation of carrying on extensive exploration not only on the Cardiff property but in several adjacent properties" now controlled by Cardiff. They include claims of the Kennebec Mining Co., Wasatch Mines Co.; Hirschman properties and claims of the former Columbus-Rexall Mining Co.

During 1960, Standard Metals Corp. spent $736,697 on completing the American tunnel which will unwater a major lead-silver-zinc-gold orebody in the Silverton District.

W. R. McCormick told shareholders in annual statement that developments in and off the American tunnel indicated a potential of more than 2-million tons of "high grade, base metal ores."

This will make Standard "not only a major producer of uranium but a diversified mining company with large reserves of uranium, gold, silver, lead and zinc," Mr. McCormick said.

Kennecott Copper Corp.'s Utah Copper Division has acted to hike the rate of waste removal at Bingham open cut copper mine.

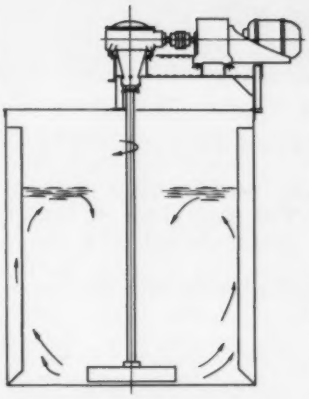
J. P. O'Keefe, general manager, announced that 200 mine workers laid off in February because of reduction of operating schedules would be rehired. The objective: to hike removal of waste area i.e. remove overburden so as to maintain ore development and stripping ratios.

6 TURBO-MIXERS HELP WRING PROFITS FROM BY-PRODUCTS AT BLACKWELL ZINC

For more than 20 years Blackwell Zinc Company, Blackwell, Oklahoma, employed secondary processors to recover cadmium from their baghouse dust. For the last three years they have reclaimed the valuable metal themselves, and General American Turbo-Mixers have helped them to realize maximum recovery.

The mixers are used at three stages of the operation: (1) preparation of slurry from products recovered from the baghouse, roasted and ground in a ball mill; (2) copper purification; (3) precipitation of the cadmium sponge.

"Our success with Turbo-Mixers has been such that their continued use will be given



serious consideration on all future expansion for our cadmium plant," says Thomas J. Woods, Chief Engineer.

The secret lies in ability of the Turbo-Mixer to provide optimum control of the variables present while precipitating off the various elements contained in the cadmium-yielding by-product according to Mr. Woods. "In three years' operation, 24 hours a day, they have required a minimum amount of downtime," said Mr. Woods. "Most of it involved only routine maintenance procedures."

For help concerning your own processing problems, write us.

Process Equipment Division—Turbo-Mixers

GENERAL AMERICAN TRANSPORTATION CORPORATION

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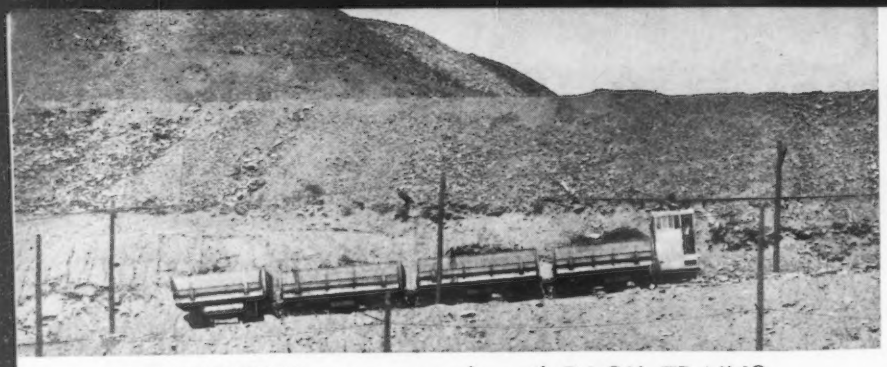
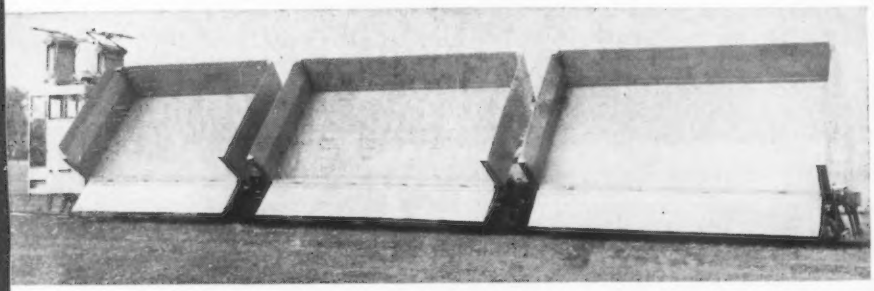


DIFFERENTIAL steep grade rail PACK TRAIN®

Up and down a 10% grade with DIFFERENTIAL ELECTRIC WHEELS for 13 years without an accident.

Uses trolley for fast climbing up 10% grade. Small auxiliary diesel-electric generator may be used for level track. With steel wheels on steel rails, tractive effort required is 5# per ton on level track, and 205# per ton up 10% grade.

Controlled speed with electric braking down 10% grade. Saves brake shoe and wheel wear. Capacities 1000 HP to 3000 HP.



PACK TRAIN uses rail all the way for lowest transportation cost. Dumps to either side all at once or one at a time.

250 HP DIFFERENTIAL two-way side dump WAGON TRAIN

A convenient way to unload. 45 ton highway train (15 tons in each wagon). 800 HP 90 ton off-highway train (30 tons in each wagon). Light weight trains haul heavy loads.

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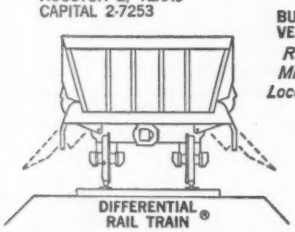
Mine Haulage Equipment
Locomotives and Mine Cars



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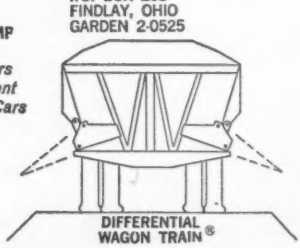


Rent Differential WAGON TRAINS from DIFCO, Findlay, Ohio

WASHINGTON

Lane Mountain Silica Co. has started production at its new $500,000 silica plant at Valley. Output started the first week of April, Charles Smith, plant superintendent, said.

Initial shipments to the glass and foundry industries would start during the latter part of April, he said.

Smith said that more than 12,000 tons of sand have been stockpiled at the firm's quarry, about 10 miles west of the plant.

When the plant is in full production, it is expected to produce about 400 tpd.

WISCONSIN

A bill introduced in the Wisconsin Legislature would permit the New Jersey Zinc Co. to run a mine shaft under a state-owned 40-acre deer yard and under several lakes in Sawyer County.

John Hague, geologist for the mining firm, said the proposed mine could yield iron or copper. He said exploration to determine ore possibilities was scheduled to begin May 1. New Jersey Zinc already has been prospecting in the area and has leases or options on about 4000 acres of land. Sawyer County is in Northern Wisconsin, but south of present Gogebic Range mines in the state and in Upper Michigan.

The Piquette Mining and Milling Co. has reopened its mill near Tennyson after an eight-month shutdown. The mill processes lead and zinc ores from the company mines in the area, now being worked on a five-day week basis with a reduced force.

IN CANADA

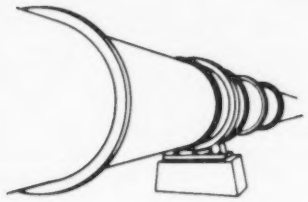
ONTARIO

The first copper producer for the veteran Porcupine gold camp was brought into production this April by Kam-Kotia Porcupine Mines. The low cost, open pit operation is located just 14 miles west of Timmins. The mill, designed for capacity of 800 tpd, is expected to be able to handle well above that figure. It has been calculated that some four year's ore is available from open pit but the company is going ahead with a deep diamond drilling program with the view to a probable underground program. Mill feed will average around 1.7% copper. Kam-Kotia is a wholly-owned subsidiary of Violamac Mines.

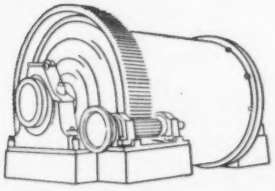
A base metal strike in Eldorado Township, some 15 miles south of Timmins, has resulted in a moderate staking rush into the area. Sampling in a gossan outcrop, 70 ft long and about 50 ft wide, returned interesting values in copper, zinc, and precious metals. The find was optioned to Noranda Mines which is to carry out a thorough test of the showing. Others, known to hold ground in the

TRAYLOR EQUIPMENT

for the mining and process industries

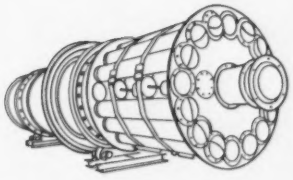


TRAYLOR ROTARY KILNS AND SLAKERS... the excellence of design and engineering of Traylor kilns is a result of over 58 years' experience in the manufacture of specialized machinery for the mining and process industries. Kiln shells are automatically welded of heavy steel plate. Alignment is maintained by easily adjusted supports. Full-floating type riding rings are of forged or cast steel, mounted on machined pads. Steel main gears and pinions are machined on a special gear generator. Kilns are designed and engineered to meet your specifications. Traylor has the most extensive research facility now available in the industry to insure delivery of process-perfected equipment to you.

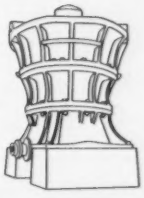


TRAYLOR BALL AND COMPARTMENT MILLS... **BALL MILLS** in both overflow and diaphram discharge types have shells of welded steel with detachable heads of cast steel.

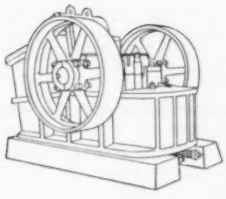
COMPARTMENT MILLS . . . partitioned by slotted diaphrams, these mills allow progressive reduction of product as it passes through different grades of grinding media within the mill, thereby reducing the amount of handling necessary in product reduction.



TRAYLOR COOLERS AND DRYERS... manufactured in diaphram and multiple tube design, receive the same care in design and construction as Traylor kilns. Dryers are either air cooled or water cooled or both and are available with direct or indirect firing, designed to your capacities or specification.



TRAYLOR GYRATORY CRUSHERS . . . Traylor is world famous as the manufacturer of giant 60″ gyratory crushers, secondary reduction crushers and fine reduction crushers. Crushers are designed with Traylor's original non-choking, self-tightening bell heads and curved concaves for large tonnage of small product and uniform size with a low percentage of waste and fines. Power applied as a direct crushing force offers greatly reduced power requirements at every setting.



TRAYLOR JAW CRUSHERS . . . feature the original curved jaw plates for greater capacities at finer settings and longer life of the wearing plates. The swing jaw is made of cast steel of extra heavy design and the pitman shaft is of annealed open hearth forged steel, for lightness with great strength. Maintainence and inspection are simplified by the design which makes all parts readily accessible.

TRAYLOR SLURRY FEEDERS AND TABLE FEEDERS... **SLURRY FEEDERS** are self contained, fully closed ferris wheel type feeders . . . accurately supply a constant volume of slurry to kilns and mills. Single welded tank and hopper units are available in sizes from 36″ to 84″.

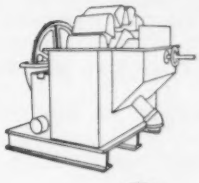
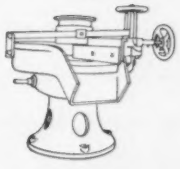


TABLE FEEDERS . . . accurately regulate the flow of material to mills, kilns and dryers. The revolving table receives material at its center from an adjustable feed spout. Feeders available from 2′ to 10′ in diameter.



See Chemical Engineering Catalog for details and specifications.

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Ontario *(Continued)*

area, include Kennco Explorations, Canadian subsidiary of Kennecott Copper Corp, Falconbridge Nickel Mines, and Texas Gulf Sulphur.

International Nickel Company of Canada is opening two more nickel mines in the Sudbury Basin area. Shaft sinking for underground operation is in preparation on the Copper Cliff North property near the company's smelting plant. The opening will go to depth of 3000 ft with initial drives to be put out at 1000, 2000 and 3000 ft to test the Copper Cliff Offset formation. The second mine is the Clarabelle open pit operation, scheduled for production by late 1961. This mine is designed to replace the Frood open pit where mining has reached the final stages. The Clarabelle is located to the southwest of the company's Murray mine.

Falconbridge Nickel Mines turned in a record performance for 1960. Production and deliveries from the company's nickel mines in the Sudbury area were at an alltime high. Deliveries of nickel amounted to 65,002,000 lb or more than 11% above the previous record set in 1959. Copper deliveries at 36,012,000 lb were better than 10% higher and cobalt deliveries at 827,000 lb showed an increase of about 13%. The company is a subsidiary of Ventures Ltd, which holds about 57% interest.

QUEBEC

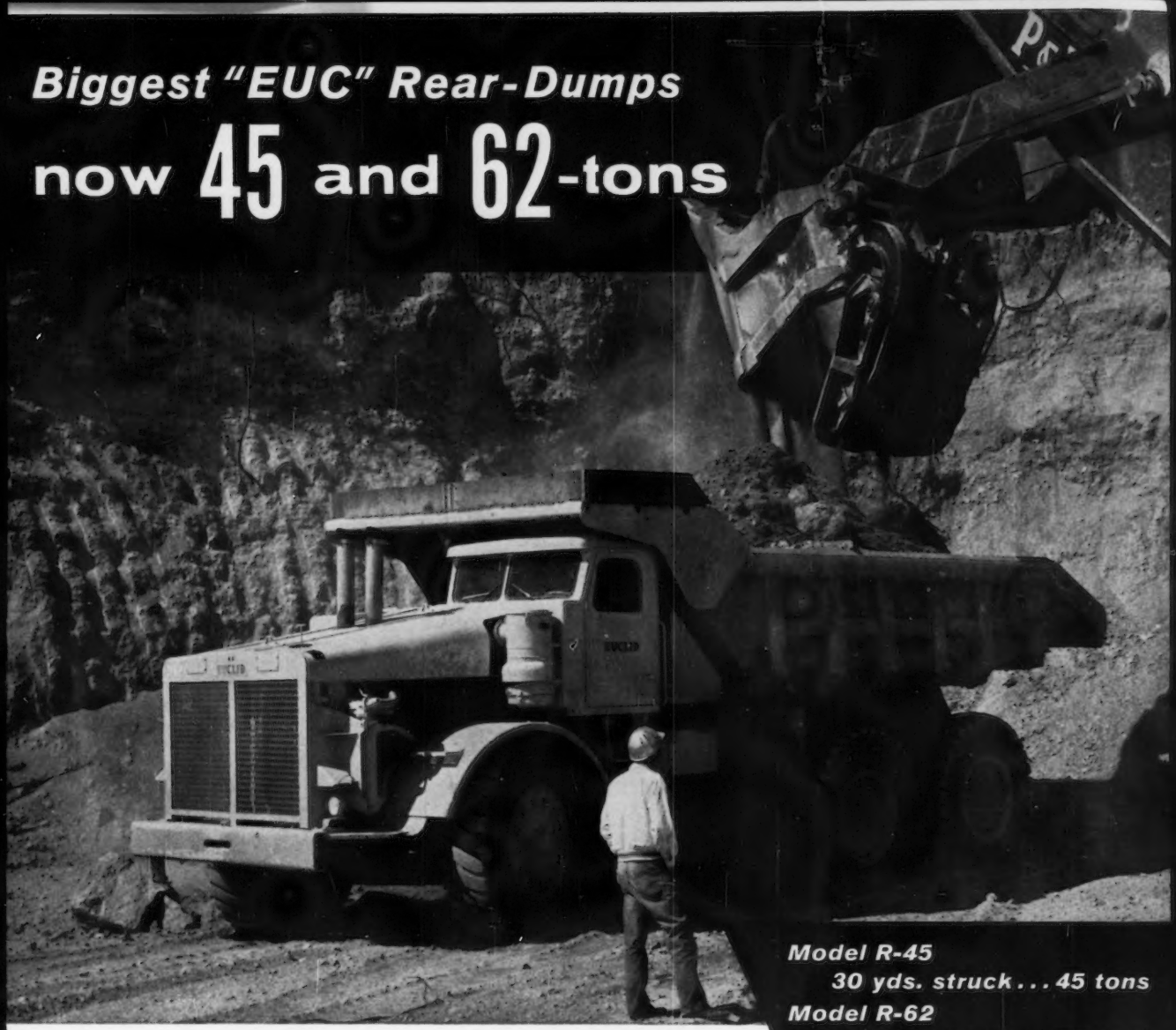
Copper Rand Chibougamau Mines turned out over 27-million lb copper in its first full year of production in 1960. Average grade of ore treated was 2.63% copper, 0.04 oz gold and 0.27 oz silver per ton. Mill average was 1551 tons per day. The large property, located in the Chibougamau area, has three underground mines, the Copper Rand, the Jaculet and the Portage Island, of which the Copper Rand is supplying the bulk of the mill feed (77% in 1960). Total ore reserves (all mines) at year end 1960 amounted to 3,178,400 tons averaging 2.79% copper and 0.066 oz gold per ton. The company is controlled by Patino of Canada Ltd., 55 Yonge St., Toronto. Mine manager is D. C. McDonald.

The Hilton Mines expanded iron pellet production by 22% in 1960 at its open pit operation near Shawville. Rated capacity of the operation is now 800,000 tons of pellets per year compared with previous rate of 600,000 tons in 1959. The open pit extends to depth of around 135 ft and will be carried to 550 ft eventually. Some 50% of the output from the mine is shipped to The Steel Company of Canada, Hamilton, Ont., while the balance goes to the U.S. The company is owned 50% by The Steel Company of Canada and 50% by Bristol Quebec Mining Co, a subsidiary of Jones & Laughlin Steel Corp and Pickands Mather & Co.

As a result of new ore developments at three mines of Campbell Chibougamau Mines in the Chibougamau area, manage-

Biggest "EUC" Rear-Dumps

now 45 and 62-tons



Model R-45
30 yds. struck . . . 45 tons
Model R-62
40 yds. struck . . . 62 tons

Designed and built for heavy off-highway service in construction, mine, quarry and industrial work, Rear-Dump "Eucs" have paced the industry for over 25 years. Now rated capacities of the two biggest models have been increased to meet field demand for still larger payloads than before.

For work under large loading shovels on the big tonnage, big yardage jobs, check these Model R-45 and R-62 "Eucs". They have payload capacities of 90,000 and 124,000 pounds and replace the widely used 40 and 55-ton models in the Euclid line of rear-dumps.

Use of high strength alloy steel for all body wearing surfaces cuts net weight and increases payload capacity . . . there's no compromise on the rugged durability and performance that "Eucs" are known for throughout the world. And, although they're new in size, both the R-45 and R-62 have years of job-proved dependability since they are of the same design and incorporate the same major components as the well-known models they supersede.

Have your Euclid dealer give you detailed information and show you how these big "Eucs" can cut your hauling costs. Euclid Division of General Motors, Hudson, Ohio

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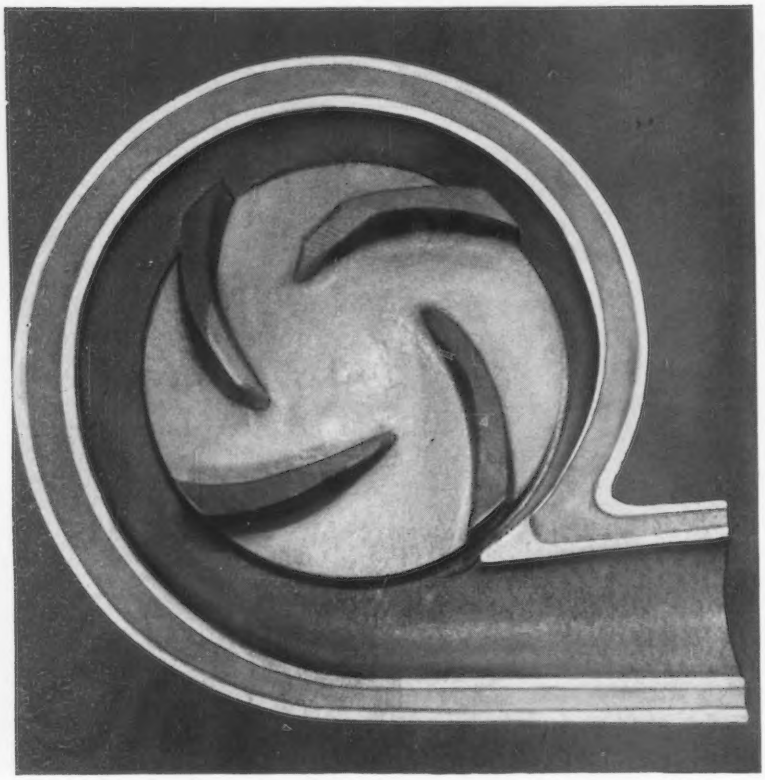
Plants at Cleveland and Hudson, Ohio and Lanarkshire, Scotland

MEEHANITE MEANS BETTER CASTINGS®



Almanite® W...New Abrasion Resisting Metal

Almanite W is a special martensitic iron and is an entirely new type of Meehanite metal possessing outstanding wear and abrasion resistance under both wet and dry conditions of service. It is now being used successfully as a replacement for high alloy cast irons and for carbon and manganese steels under **abrasive conditions such as hydraulic mining.**

The Almanite impellor shown was tested at Mt. Morgan Mining Company, Queensland, Australia in a Warman Cyclone Feed Pump used for the pumping of gravel sludges. Test results listed below demonstrate the superior service life of Almanite W over other materials in which this impellor was previously cast.

White Iron	*7 to 8 days*
Alloyed White Iron	*10 days*
Martensitic White Iron	*9 to 11 days*
28% Chrome Steel	*14 days*
Special Nickel Steel	*16 days*
ALMANITE W	*21 days*

Almanite W can readily be cast in all forms and shapes and is available through Meehanite foundries only. For more information, write to Meehanite Metal Corporation, 714 North Avenue, New Rochelle, New York.

MEEHANITE METAL

MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES.

Quebec (*Continued*)

ment is considering the possibility of further mill expansion beyond the present objective of 3000 tpd. New ore structures have been indicated at the Cedar Bay mine, the Henderson and the main Merrill Island mine.

NEW BRUNSWICK

The Consolidated Mining and Smelting Co. has scheduled production for its Wedge copper property for the end of 1961. The property is located 26 miles southwest of Bathurst. The mill is to be designed for rate of 750 tpd and arrangements have been made with Heath Steele Mines to use part of its 1500-ton capacity mill to treat ore from the Wedge. The Heath property is about 10 miles to the south.

NORTHWEST TERRITORIES

Twenty-seven prospecting permits for mineral exploration in the Northwest Territories have been issued under the new Canada Mining Regulations. In accordance with these regulations, applicants have made deposits totalling $400,000 as guarantees for exploration expenditures in 1961.

Successful applicants at April 2 include: Giant Yellowknife Mines, Ltd., 13 permits in Keewatin District; Selco Explorations, Ltd., 3 permits in Keewatin District; Bankeno Mines, Ltd., 4 permits in Arctic Islands; North Rankin Nickel Mines, Ltd., 2 permits in Keetwatin Distirct; Canada Tungsten Mining Corp., 4 permits in southwest portion of Mackenzie District; and Fort Reliance Minerals, Ltd., 1 permit in southwest portion of Mackenzie District.

BRITISH COLUMBIA

A flurry of prospecting activity in the Prince George area has followed a report by the B.C. Department of Mines of seven large bodies of "ultra basic" rocks.

The find was among discoveries made during the 1960 field work of the Geological Survey of Canada. Cassiar Asbestos, McIntyre Porcupine and Nicholas Asbestos are among the companies showing interest.

Cariboo Gold Quartz Mining Co. Ltd. announced its ore production was down but gold output rose $70,000 in 1960.

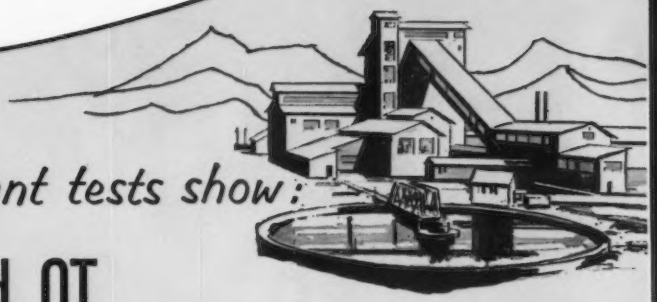
W. B. Burnett, president, said the reason was that the company had been able to locate and mine the richest ore it has known. He expects the new grade will be maintained for some years.

Centennial Mines, Magnum Copper Ltd. and Canex Aerial Exploration Ltd. plan a $125,000 tungsten prospect exploration program in the Northwest Territories. The property, comprising 67 claims 150 miles north of Watson Lake,

CYANAMID

Reagent News

ore-dressing ideas you can use



Colorado plateau plant tests show:

AEROSOL® C-61 and OT
Surface Active Agents improve Leaching, Thickening and Filtration

Recent reports from leading uranium producers indicate remarkable success for AEROSOL Surface Active Agents in uranium ore treatment.

AEROSOL OT-75%, an easy-to-handle liquid, improves the penetrating action of leach solutions, reduces acid consumption, lowers ultimate tailings and provides other beneficial side effects. AEROSOL C-61, a water soluble paste, reduces moisture content in final yellow cake filtration.

Plant A treats 480 tpd by acid leaching with 85 lb/ton H_2SO_4, 1.5 lb/ton Na_2ClO_3 following this with solvent extraction using a tri-fatty amine. An additional 240 tpd are treated by carbonate leaching with 30-40 lb/ton Na_2CO_3. AEROSOL OT-75% is added to both circuits at rate of 0.1 lb/ton. Pregnant liquors from both circuits are combined and uranium recovered by NaOH precipitation. Use of AEROSOL OT has reduced acid consumption by 30 lb/ton (115 vs. 85 lb/ton).

Plant B treats 300 tpd by acid leaching with 217 lb/ton H_2SO_4, 2.7 lb/ton Na_2ClO_3 following this with resin-in-pulp (RIP) recovery of uranium. AEROSOL OT at the rate of 0.1¢/ton lowers ultimate tailing and increases overall recovery by 2%. In addition, due to AEROSOL OT, efficiency of sand-slime separation circuit has improved in both cyclones and CCD classifiers. A decrease in sliming over on resins and a somewhat improved flow through the baskets has been noticed.

Plant C treats 450 tpd by acid leaching with 45 lb/ton H_2SO_4, 1.5 lb/ton Na_2ClO_3 and 0.18 lb/ton AEROSOL OT-75%. Uranium is then recovered by solvent extraction with an amine. Estimated saving of $0.80/ton in acid has been realized due to AEROSOL OT. In addition, while AEROSOL OT is added to leach circuit, enough carries through to eliminate the nuisance of scum from #1 CCD thickener.

Plant D treats 5000 tpd by acid leaching with 300 lb/ton H_2SO_4, 3.0 lb/ton Na_2ClO_3, followed by uranium extraction with a tri-fatty amine. C-61, added to the yellow cake slurry at 5 lb/ton, has lowered moisture 5 to 6% (50 to 44%).

AEROSOL OT-75% has also shown benefit in acid leaching of copper and zinc and has found wide application as a filtration aid for improving cake quality and reducing cake moisture in filtration of sulfide concentrates.

AEROSOL Surface Active Agents may lead to savings at your operation. Send for samples today.

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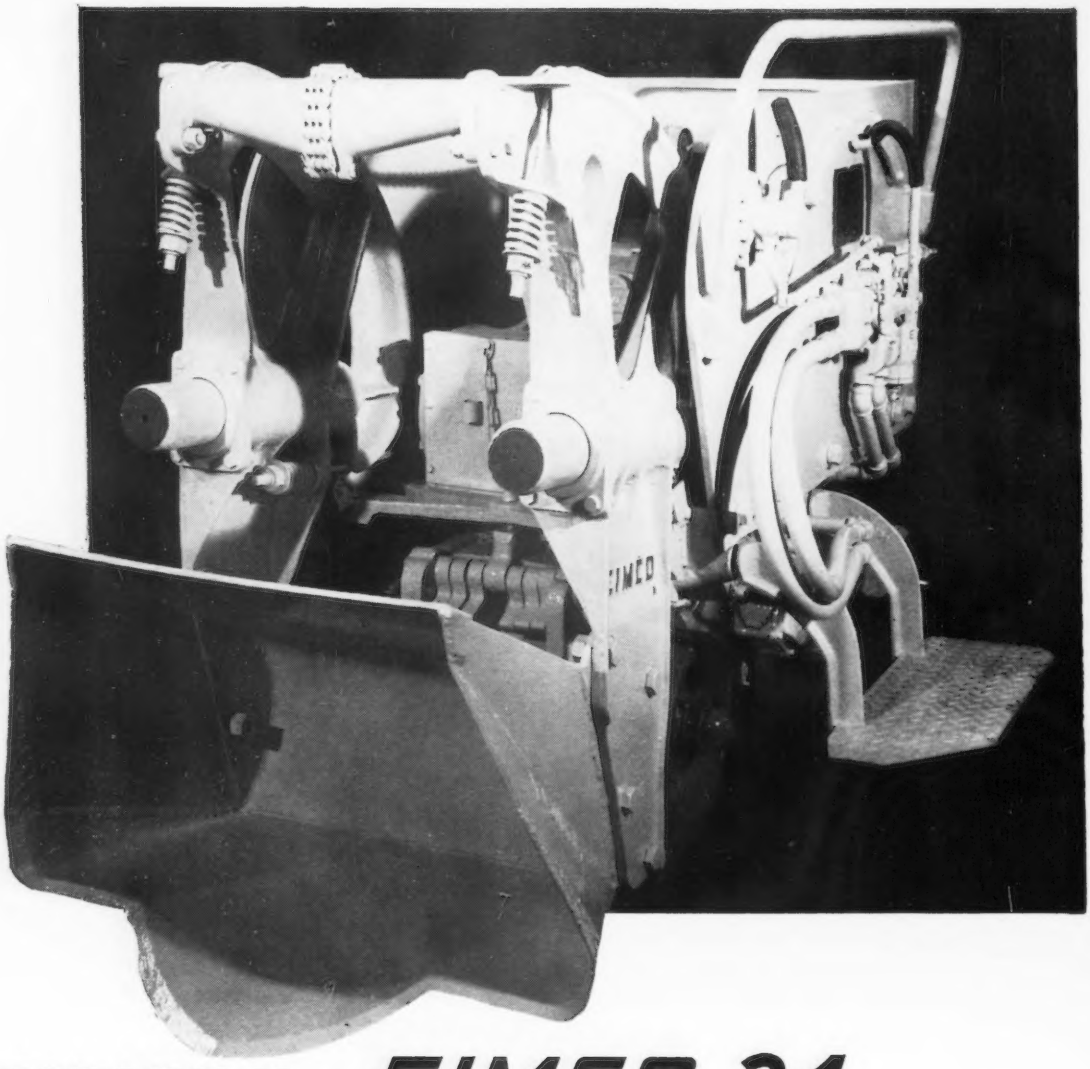

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Compare loading capacities. Compare construction quality. Compare operating costs. Compare meaningful engineering features. Get all the facts on the faster loading, more versatile new Eimco 24 RockerShovel loader, proud successor to the famous Eimco 21, before you buy any rail-mounted loader and you'll agree that here is indeed a new standard of performance and quality. Write for Bulletin L-1140-A, to The Eimco Corporation, P.O. Box 300, Salt Lake City 10, Utah, U.S.A.

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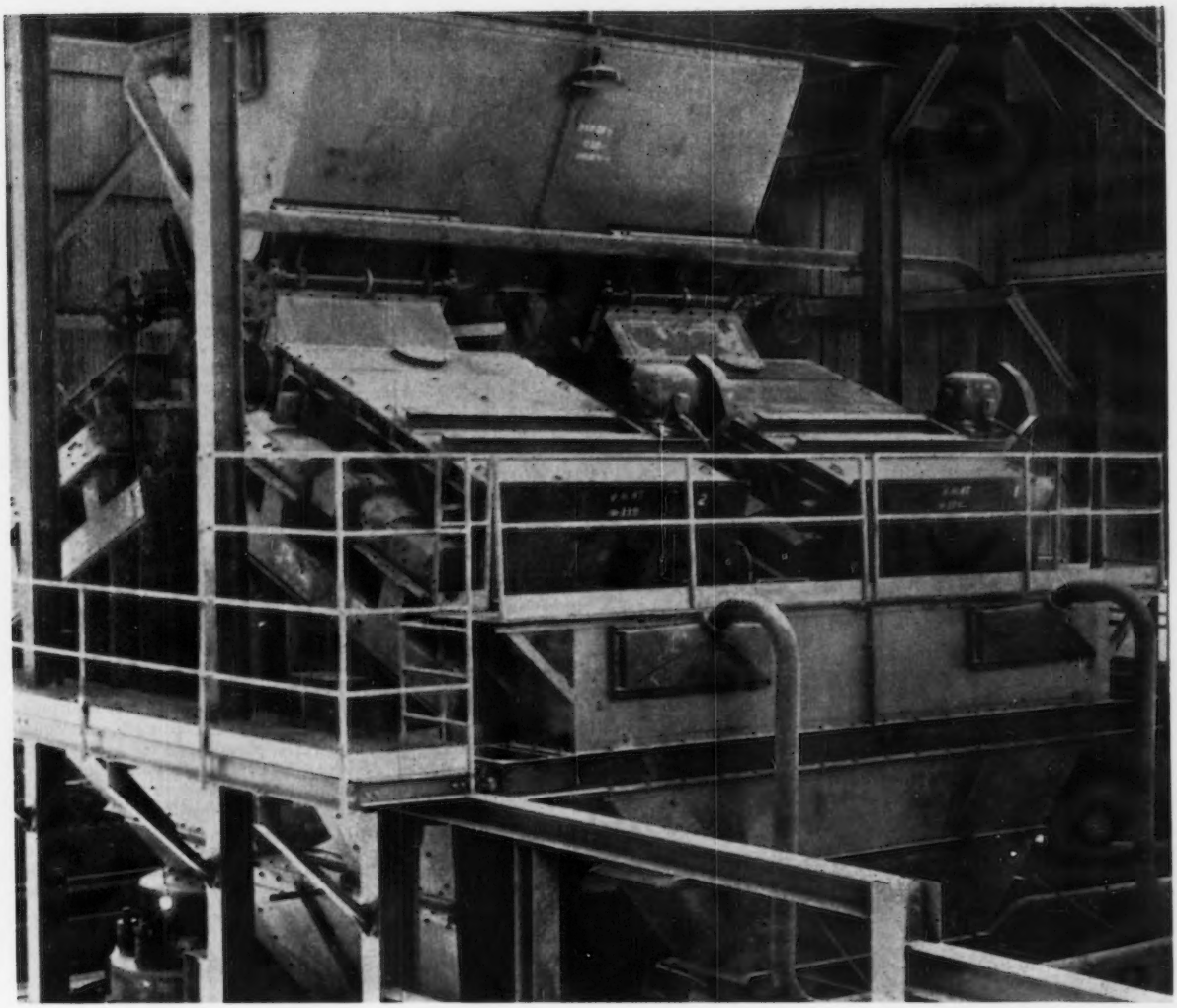
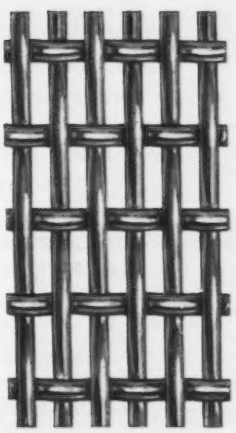


In 7 years of operation Tyler Ty-Rocks screen 15,000,000 tons of ore at Silver Bell Mine... "maintenance virtually nil"

These four single-surface Ty-Rock screens at the Silver Bell Mine of American Smelting and Refining Company have screened mountains of copper ore. Yet in seven years of operation the company reports "no bearing or other major replacements, and maintenance virtually nil"... a tribute to the fine operating staff and to the design of the equipment.

Tyler vibrating screens handle tremendous outputs with very high reliability. And no matter what your screening requirements, Tyler can handle them: heavy duty mechanical screens, electric screens, economical two-bearing screens. And—Tyler is the world's largest manufacturer of wire cloth and fabricated screen sections.

For screening equipment perfectly matched to your needs check with Tyler.



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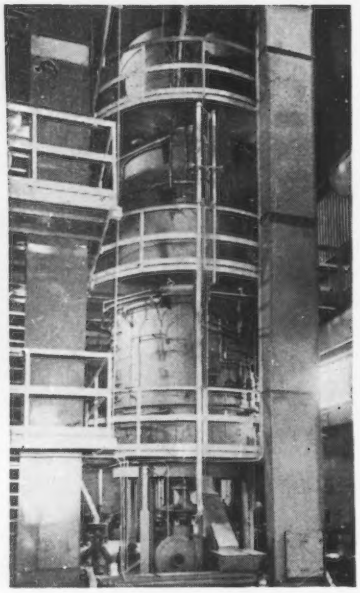

If you have a Drying, Roasting, Calcining or Decomposing problem...

a Skinner Furnace

may be the answer

Successful applications of the Skinner Furnace include:

Oxidizing Roast

- Roasting Molybdenum Sulphide Concentrates
- Roasting Zinc Ores
- Calcining of Basic Alum, Clays, Foundry Sand, Carbon, etc.
- Incineration of Sewage

Chloridizing Roast

- Roasting Uranium-Vanadium Ores

Reduction Roast

- Decomposition of Oil Sludge
- Lime Burning
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Drying

- Drying Uranium-Oxide Precipitate
- Drying Copper Concentrates
- Dehydration of Alunite

Many other applications are possible ***because of the flexibility in construction and operation of the Skinner Furnace...***

- 2 to 14 hearths
- 4'0" to 23'6" dia.
- 22 to 4000 sq. ft. hearth area
- Direct or indirect fired with coal, oil or gas
- Variable rate of feed and retention time
- Up or down draft
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- ¾" to minus 325 mesh material
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IN LATIN AMERICA

CHILE

The German firm of Wedag has won the contract for building at the site of the Paipote Copper Smelter in Atacama a modern 500-tpd flotation mill. The cost of the machinery will be U.S. $625,000 plus another $200,000 for foundations, etc. It also approved to invest up to U.S. $400,000 in credits to the small miners up to that sum to be paid back at low interest rates within 3 years.

The official inauguration of the Mantos Blancos leaching plant located near the railroad depot of Arturo Prat on the railway from the port of Antofagasta to La Paz took place on March 27. The mine is located 28 miles due east from Antofagasta and has a capacity of 18,000 tons of fire refined copper per year, the principle valuable mineral being atacamite, the oxichloride of copper. At the ceremony were present Señor Mauricio Hochschild to whose energy, courage and technical organization the opening of the mine, the development of a special process to treat the difficult ore is due; Señor Videa Lira, president of the Mining Society and Señor Joaquín Fernández, president of the company and who was Secretary of State during the Administration of President Rios.

The development of the process for treating the ore and the design of the plant is the work of Richard Knobler and his assistants.

VENEZUELA

Iron ore production of Orinoco Mining Co., US Steel subsidiary, registered an 18% decline in the first quarter this year as compared with the corresponding period of 1960.

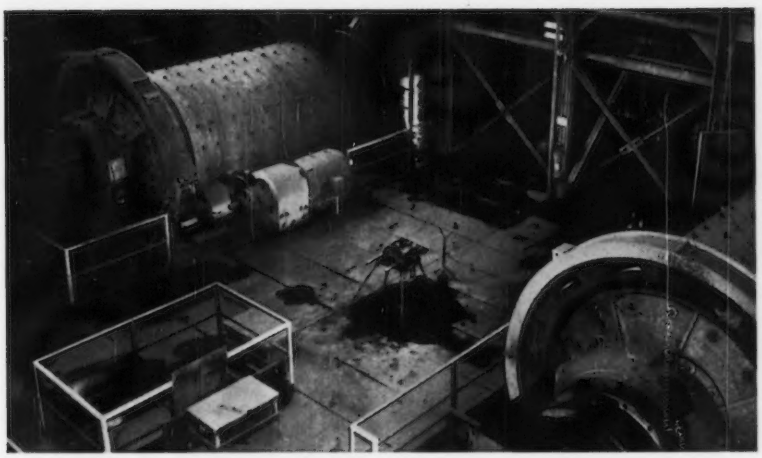
Output through March 31 was 3,446,-271 metric tons, a drop of 745,900 metric tons from the total of 4,192,171 metric tons in the first three months last year.

ARGENTINA

Kaiser Refractories & Chemicals Division has concluded a licensing agreement with Ceramica Olivos S. A., Buenos Aires, for the manufacture of basic refractories and fire clay specialty products.

The South American firm will produce these products at its Buenos Aires Plant. Ceramica Olivos S. A. has been manufacturing high quality refractories, particularly special refractory shapes for nearly twenty years.

Seawater periclase, the principal ingredient used in making basic refractories mixes, will be shipped from Kaiser's Moss Landing, Calif. plant. High quality raw materials from Argentina and from other world sources will be used for the production of fire clay, high alumina, sillimanite and other specialty products.



Marcy Scrubbers

PROVED PERFORMANCE *on the* MESABI IRON RANGE

A prominent mining company in Minnesota is using two 9½'x 19½' Marcy Heavy Duty Scrubbers in one of its concentrators, on a tough iron ore cleaning problem. This installation followed use of Marcy Scrubbers in two of the company's other concentrators.

Proved Advantages of Marcy Scrubbers

- The Marcy principle of small diameter, long length scrubbers gives...
  longer time of positive, active scrubbing,
  less short-circuiting
  which results in more *effective* scrubbing with less horsepower.
- Heavy duty construction, operation on trunnion bearings, and properly designed drives, combine to eliminate vibration.
- With trunnion bearing design there is no maintenance problem due to corrosion and abrasion.

TYPICAL LOCAL SERVICE
This Minnesota installation was engineered and serviced through the cooperation of the mining company, Mine and Smelter, and its agent, Continental Sales and Equipment Co., Hibbing.

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PHILIPPINES

The Philippines will have a new gold producer this year according to Charles A. Mitke, president of the Manila Mining Co., when the company completes construction of its mill at Agusan, Mindanao. Development work has been concentrated on the high grade portions of the orebody which are showing up well.

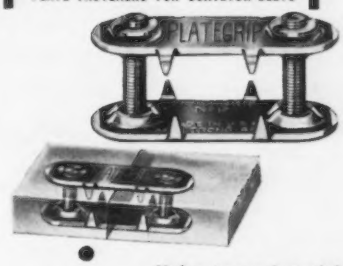
Barlo Mine, a new property in Tasol-Mabini, Pangasinan sent 1190 tons of direct shipping ore to Mitsubishi smelter, averaging 8.6% copper. Larger shipments are scheduled as development is showing good ore at depth. Juan Escobar is president of the company.

The annual report of Atlas Consolidated, largest copper producer in the Philippines, indicates the company made a net profit of 2,172,000 pesos ($1,086,000) after taxes in 1960.

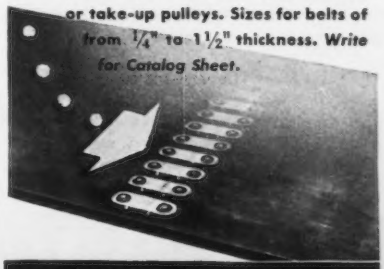
The Newmont Mining Corp. has completed all phases of its exploration program but wishes to make additional and more detailed photogrammetric mapping of the area. Jacques Claveau has been loaned by Newmont for guiding detailed geological studies of the Lutopan pit as well as the Penaba and Lantoy areas.

During the year 3,351,000 tons of ore were milled averaging 0.61% copper and 11,354,000 tons removed in stripping. Total copper production was 35,671,000 pounds. At the end of 1960 ore reserves were estimated at 106.8-million tons averaging 0.69% copper.

PLATEGRIP
PLATE FASTENERS FOR CONVEYOR BELTS



- **Make strong dust-tight, water-tight joints in belts of any width. Special design spreads tension uniformly across belt, allow natural troughing of belt and assures smooth operation over flat, crowned or take-up pulleys. Sizes for belts of from ¼" to 1½" thickness. *Write for Catalog Sheet.***



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Price $80.00 per Unit

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IN AFRICA

A copper furnace being erected at Tsumeb in South-West Africa is expected to be completed in January next year while a lead smelting furnace will commence operation in 1963.

The Rio Tinto organization is proceeding with the exploitation of its copper deposits in South-West Africa. The company has started to sink shafts on a farm in the Okahandja district. Two shafts have been sunk while a third, which dates back to developments before the First World War, when South-West Africa was German colonial territory, is being pumped dry.

A pilot plant for the production of uranium metal and salts has been opened in Johannesburg by the Minister of Mines, Senator Jan de Klerk. The plant which is under the control of the Government Metallurgical Laboratory, is capable of treating about 100 tons of uranium yearly.

The first Nigerian tin smelting plant has been opened at Makeri. The $1.4-million installation is the Portuguese owned Nigeria Embel Tin Smelting Co. Ltd. At present the company has one furnace operating. Later it will have 12 furnaces and will able to smelt Nigeria's entire tin production (which has averaged from 8500 to 12,500 tons over the last four years).

IN EUROPE

ITALY

A new plant for the processing of pyrite is to be built by Montecatini, at Follonica (Grosseto) on the Tuscan coast. Building of the complex started in April and the plant is expected to go on stream in June 1962. Initially it will produce 170,000 metric tons of iron ore, 350,000 metric tons of highly concentrated sulphuric acid, and will give employment to 150 persons.

The new plant will apply, for the first time in the world, original patented processes for the extraction from pyrite of ferrous minerals as a primary product for the metallurgical industry.

The pyrite will be supplied by the nearby mine of Niccioleta, by means of a cableway, at the rate of 1300 metric tpd, and will be immersed into two big roasting furnaces so as to liberate under the form of sulphur dioxide the sulphur contained in it. The solid residues of impure ferro oxide will then be purified in special furnaces. The product thus obtained will have a very high iron content (an average of about 65%), and will finally undergo an agglomeration process so as to render it more suitable for metallurgical uses.

From the sulphur dioxide highly concentrated sulphuric acid will be obtained, which is to be partly utilized by Montecatini's plants, and partly sold to third parties.

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Ore Carriers Move It • FASTER • EASIER • AT LOWER COST

SCOOT-CRETE CD-4, shown being loaded in mine, will carry up to 15 tons payload. Model CD-3N has 5-ton payload. Note driver's side-mounted position for maximum vision and efficiency, forward and rear.

Throughout the world, SCOOT-CRETE gives top-rate performance. No rails needed, no ties, no cars, no independent power source. Diesel-powered for operation inside the mine, SCOOT-CRETE carriers are rugged for around-the-clock service; carry up to 15 tons at speeds to 15 mph, climb grades up to 18%. Available with standard or fully automatic transmission. SCOOT-CRETE has equal speeds forward and reverse for fast shuttle service.

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AIR VIBRATORS

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Navco vibrators on exterior bins keep wet and frozen material moving at this Wisconsin plant. Solenoid valve gives automatic operation and control of bulk material.

Navco "Long-Stroke" Air Vibrators dislodge arched material with a timed piston impact . . . do not "pack" materials with high frequency vibration. Exclusive patented "one-piece" design eliminates body assembly bolts, cuts vibrator maintenance up to 80%. Easy to install, units will operate in hazardous atmospheres, inclement weather or magnetic dusts.

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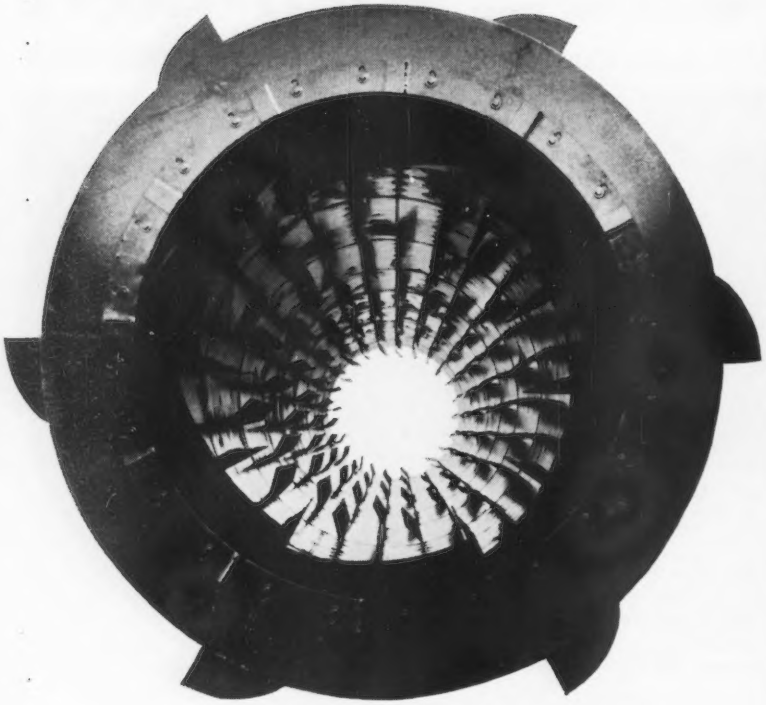

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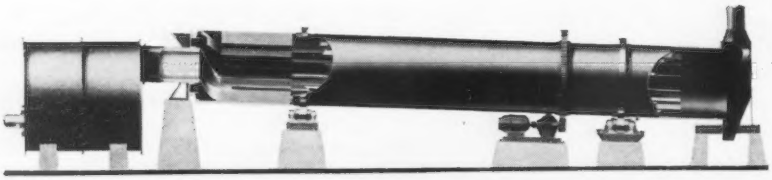
with Ruggles-Coles "XH" Dryers

The Ruggles-Coles "XH" Dryer is adaptable to the handling of any material that can be dried in rotary equipment. For example, Hardinge offers three types of feeders, one of which is best suited to the material being processed. Write for Bulletin 16-E-1.



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ISRAEL

About 1500 tons of cement copper (approximating 80% copper contents) were shipped in March from Eilath port (Red Sea) to the Far East. This is the largest single quantity to be dispatched so far by the government-owned Timna copper mines, near Eilath. The destination country was not specified.

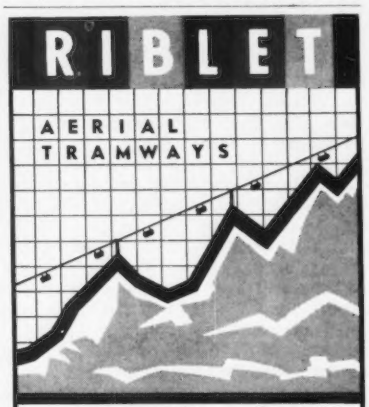
This follows another recent consignment of about 1200 tons which were dispatched from the same port.

Above quantities are part of a contract which provides that 50% of the Timna output will be sold to an unspecified Far East country, over the next two years.

Symposium *(Continued)*

of packed beds. The theoretical solution of bed-cooling derived by Schumann in 1929 was mentioned as useful, but its limitations were brought out where large lumps of sinter, over 1-in. in dia, are involved. An analysis developed by Gurney and Lurie in 1923 was shown to be applicable to large lumps, and complementary to the Schumann method.

For cooling lumps of over 4-in.-dia, air flow is not controlling; the best approach is to provide adequate residence time in the cooler. For 8-in. lumps, a residence time of over 1 hr



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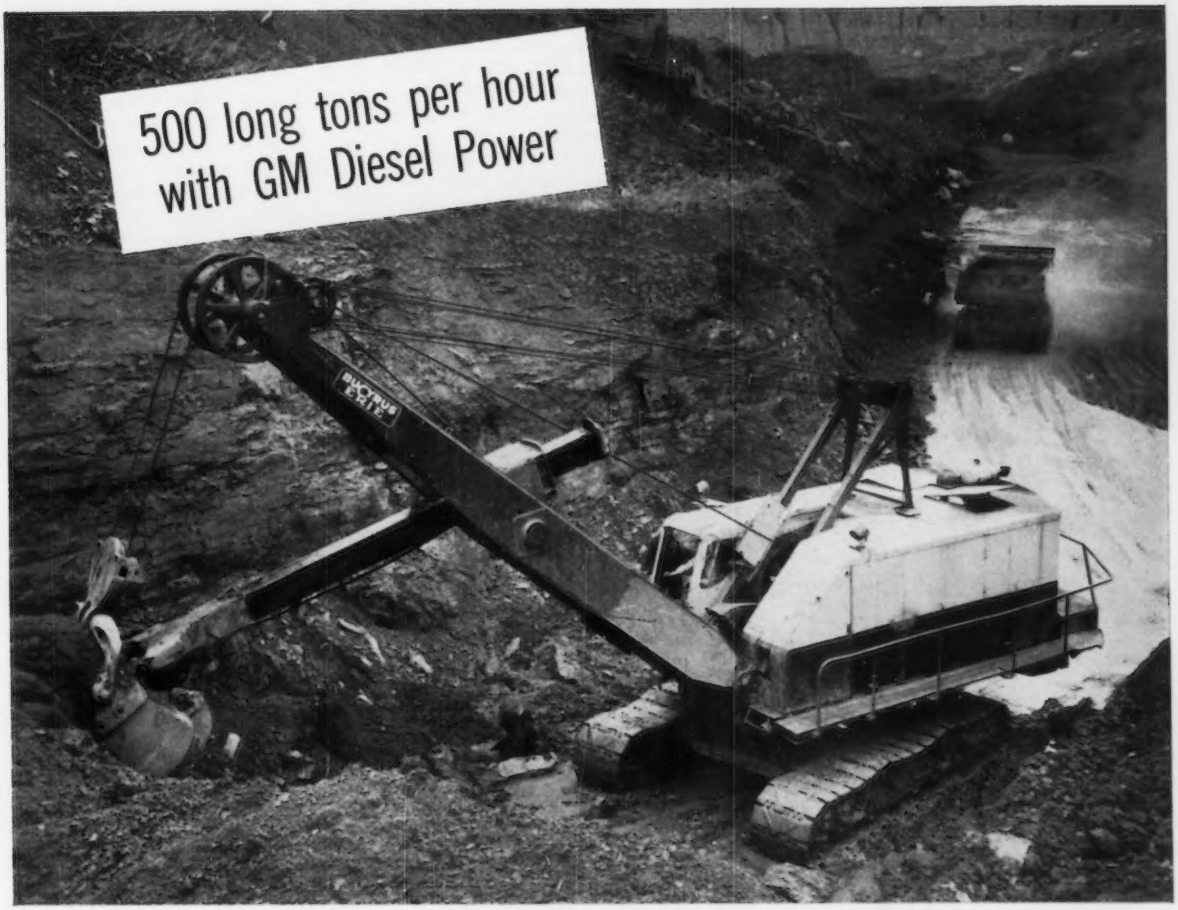

When you can get a shovel to move 500 long tons per hour—4,000 long tons every eight-hour shift—you're getting *real* productivity.

And that's exactly what one of the big mining companies on the Mesabi Range is getting with their Bucyrus Erie 71B shovel powered by a "Jimmy" Diesel.

The unit is used for a variety of jobs —is easy to move—saves a lot of time over electric-powered shovels because it has no electric cables to drag around.

Its performance record is one reason why this company also operates scores of GM Diesel-powered units—drills, pumps, earthmoving vehicles, as well as shovels. They report over 18,000 hours on some "Jimmys" with no overhauls, say that more of the GM Diesels in their earthmovers are over the 15,000-hour mark with no major parts replacements.

Got a power problem? Not getting the work you want from your equipment? Call your GM Diesel Distributor. He's part of a coast-to-coast network of "engine people" you'll find in the Yellow Pages under "Engines, Diesel." Write direct if you prefer—we'll send you the information you need.

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Symposium *(Continued)*

is necessary. Air flow is significant only between lumps; through any individual lump it is negligible.

Going from theory to practice, Dr. Young discussed several points in selection and design of a sinter cooler. The designer should use measured heat-transfer coefficients wherever possible, based on the sinter to be handled; he should use the Schumann analysis only with great caution, and may use the Gurney-Lurie analysis as a rough guide for large lumps. The pressure drop for a proposed plant should be carefully estimated, and the fans chosen to give maximum power economy, though with some flexibility. Forced-draft fans have the advantage over induced-draft fans that they handle clean, cool air, thus need less power (less volume handled) and are not subjected to such severe conditions. Large lumps must be given special consideration. They must have adequate residence time, which may be provided by scalping them from the sinter stream and giving them special, secondary cooling.

The authors compared a deep-bed (7-ft), annular type of cooler, with discharge pushed out by a plough, with a shallow-bed (15-in.), linear type. The deep-bed type showed superiority in a number of features, including power efficiency, ultimate discharge temperature, residence time, and mixing of bed (thus minimizing "hot spots").

R. F. Jennings delivered the paper he co-authored with A. Grieve, also of the firm of Huntington Heberlein & Co., London. In a wide-ranging discussion of "The Basis of Sinter Plant Design," Mr. Jennings touched upon: Capital costs, raw materials storage and handling, coke breeze preparation, mix proportioning, surge bins, later mix treatment, strand feed, multilayer feed systems (both hearth layering and double layering), strand size, fans, air preheating, sinter cooling, dust collection and automation. The authors presented the various components of each area, with recommendations for the most influential cost factors. Among the observations made during the question and discussion period following the presentation were the following:

1) Addition of electrostatic dust collection equipment can increase capital costs by 7% in a table of relative capital costs. But, as the author observed, "You pays your money and you takes your choice." If the equipment is necessary and practical, the cost must be borne.

2) The authors and others who participated in later discussion reemphasized the importance of careful blending of the charge.

3) Optimum bed thickness varies with the many differences in ore, type of equipment, output, etc. Youngstown Sheet and Tube has found an 8- or 9-in. bed necessary to get correct permeability. "In Britain we've even gone down to 6," said Mr. Jennings.

4) Dust-collection efficiency of 85% is no longer enough at the stack discharge, said U.S. Steel's R. A. Groenendyke. It is, if the laws permit, said the author, but he agreed that demand was for greater and greater efficiencies.

5) More and better research is needed in all phases of the operation, authors and audience agreed, but the former noted that it now takes about four years for progress in research to affect the operations. Perhaps computers and the logging of downtime as a fault-finding technique would help.

T. E. Ban led a four-author team from the Dwight-Lloyd Research Laboratories of McDowell Co., Inc. and emceed the "off-Broadway" presentation of research and applications of the continuous sintering process. With professional skill and split-second timing, Dr Ban and his associate on the

Photo - Courtesy, United States Steel Corporation.

Tough cars for a big job . . .

In 65 years or so the first dipper hole at Mesabi has grown to the tremendous open pit pictured here in part. Differential Air Dump Cars first put in appearance at Mesabi in 1925. Veterans of many years and thousands of tons, these cars have carried their loads uncomplainingly. Steady reorders have a pleasant way of nodding approval. We would be glad to tell you more about Differentials — how they're made and why you'll like them.

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DIFFERENTIAL STEEL CAR COMPANY FINDLAY, OHIO

MOST VERSATILE AND EFFECTIVE

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THROUGH

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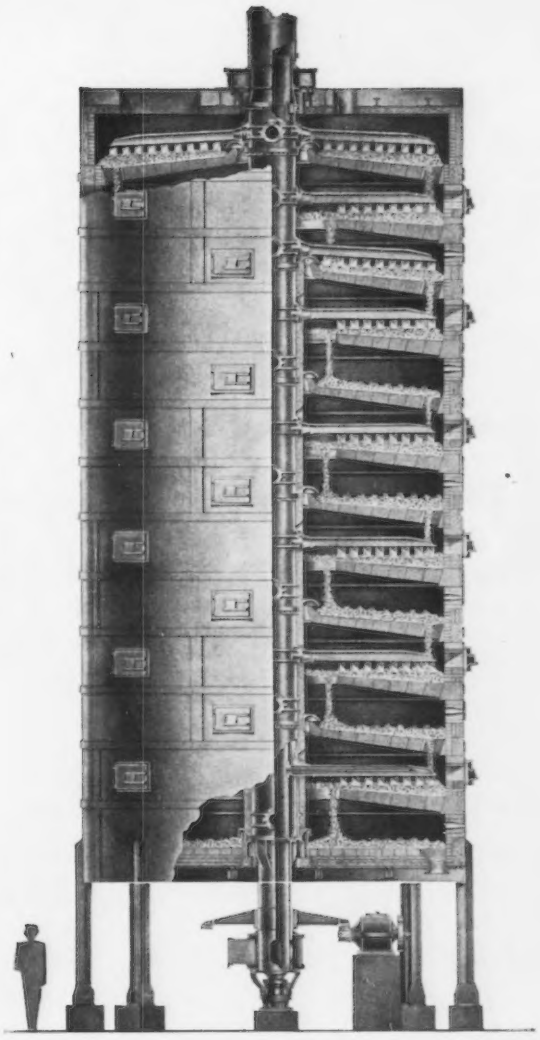

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slide projector introduced the process mechanism and then swung into a three- and four-color graphic recital of the process as applied to iron ore; limestone and concentrate; hematite concentrate, limestone and bentonite; lead concentrate; shale and sandstone; flyash; flyash and sewage sludge; shale and limestone; oil-shale and limestone; and phosphate shale and phosphate rock.

Alan English and M. J. Greaves, of Arthur G. McKee & Co., Cleveland, shared the podium and the fielding of questions from the floor after presentation of their "Engineering Contributions to New Techniques of Iron Ore Agglomeration." After forecasting an impressive increase in pellet consumption in 1970 (see chart) vs a less spectacular growth for sinter, the authors discussed a number of engineering trends in types of agglomerators.

Among the points discussed in detail were: 1) the change of supply from solely domestic and traditional materials to the use of magnetite and hematite concentrates and iron ore fines from Latin American deposits; 2) increase in optimum widths from 8 ft to 10, 12 and 13 ft. High temperatures presented problems here, but coolers and dust collectors were introduced to combat them; 3) and, finally, the introduction of automation.

Automation, as Mr. English observed, was "built in" as pelletizing grew, but it is not so common in the field of sintering.

As one of the most striking results of the growth of pelletizing, Mr. Greaves noted that the practice is integrated at the mine site, and not at the furnace. He also presented the following statistics: "About 5-million tons of pellets per year are currently produced by the downdraft-grate pelletizing method. . . . Pelletizing machines today are capable of producing between 2500 and 3200 tpd of pellets, and designs are well along for 5000 tpd capacity machines."

In a discussion following presentation of this very valuable paper, Mr. Greaves answered a question about automation controls, noting that controls could probably be placed in the areas of moisture control (perhaps using a nuclear device since stack gas analysis takes so long), in burn through or end-point control (where probes and load cells might keep strand speed constant) and elsewhere as instantaneous gas analysis became more possible.

In another discussion, the authors' estimation of a relaxed growth of sintering application (see chart) was challenged by the suggestion that sinter and self-fluxing sinter will expand greatly.

Fred Cappel, of Lurgi, West Germany, presented the paper which he co-authored with H. Rausch of the same firm, to an extremely attentive audience which subsequently presented an unusual amount of comment on the subject of conventional, hot air, and mixed fired sintering of iron ore.

Herr Cappel pointed out that his firm's tests indicated advantages in reducibility and total fuel consumption with the use of "mixed firing" or hot air over the conventional use of air at ambient temperatures.

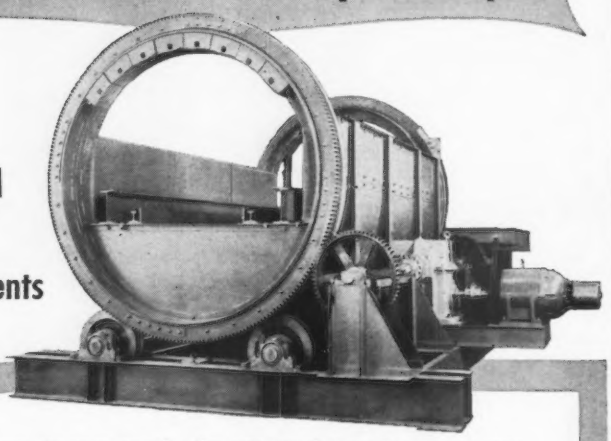
The "mixed firing" process consists of burning gaseous or liquid fuel with excess air in a burner hood covering a part of the sintering machine and drawing the combustion products (at 700 to 1200° C) through the charge. The amount of coke needed in the mix was decreased, in the tests run by Lurgi, depending upon the hot gas temperature.

While there was a limited decrease in sinter output (to a lesser degree with oil than with hot air because of the extra moisture in the hot air) the

(*Continued on p 152*)

FOR FAST, SAFE CAR DUMPING

Connellsville Rotary Dumps



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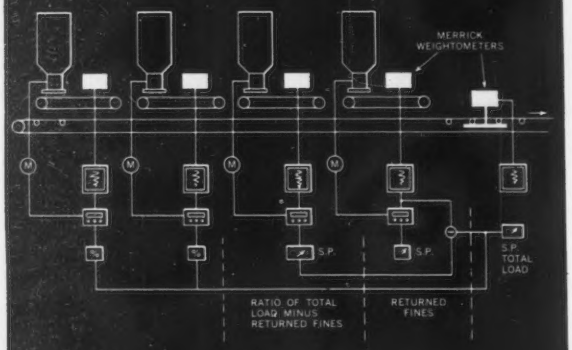

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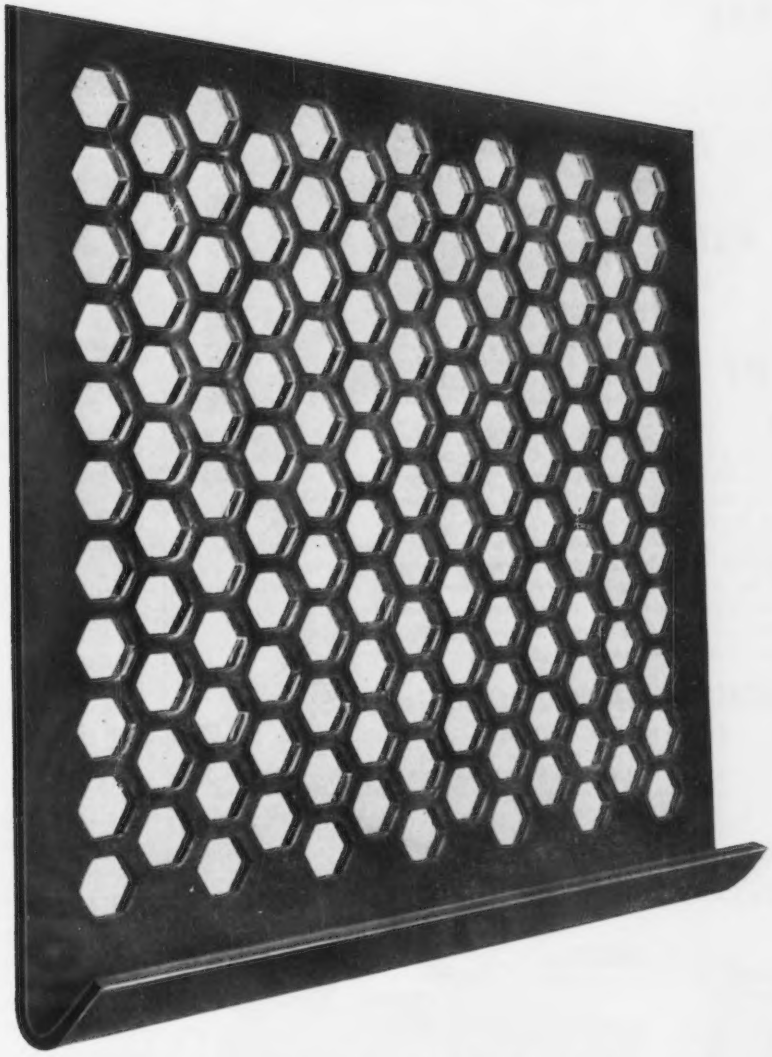

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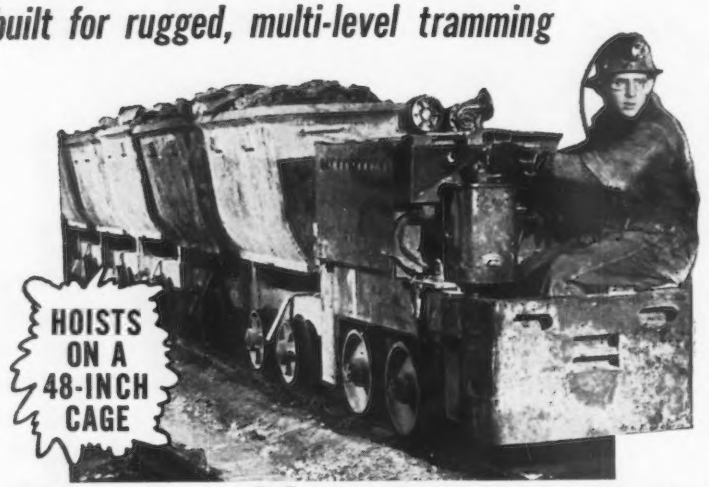

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Symposium *(Continued)*

speakers were convinced of the worth of the process in fuel economy. Mr. Rausch and Mr. Cappel noted, though, "that the saving achieved in total heat is not directly proportional to the increase in sintering gas temperature. The saving achieved with temperatures between 700 and 1200° C is disproportionately higher than that achieved with lower temperatures."

The authors noted that the type of ore must dictate the choice of fuel, and cited examples of Venezuelan, French and Ruhr ores, with the rather widely different results obtained in testing each.

Donald Ingvoldstad and Kenneth K. Kirkpatrick, of Bunker Hill's lead smelter at Kellogg, Idaho, discussed the preparation of raw material charge in the sintering of lead concentrates, with particular emphasis on the system which their own firm has introduced at Idaho, where expansion of equipment and more particular care in charge preparation, mixing and pelletizing have resulted in greater blast furnace output. The following table shows relative smelting rate (tpd of total charge):

	tpd	coke added
8 months before program	565	11.6%
8 months after program	831	10.95
March 1961 average . . .	908*	9.92*

(* The authors noted at the symposium that the March figures, not available for the preprint, need to be qualified. Blast furnace alterations, including a taller column and larger tonnage, deserve some credit for the lower coke charge.)

In creating the charge, Bunker Hill improved former practice by 1) incorporating all charge ingredients except coke into the sinter and more carefully proportioning and mixing the ingredients; 2) grinding to the economic minimum for effective furnace reaction; 3) carefully controlling moisture for pellet strength, porosity, storeability, etc.

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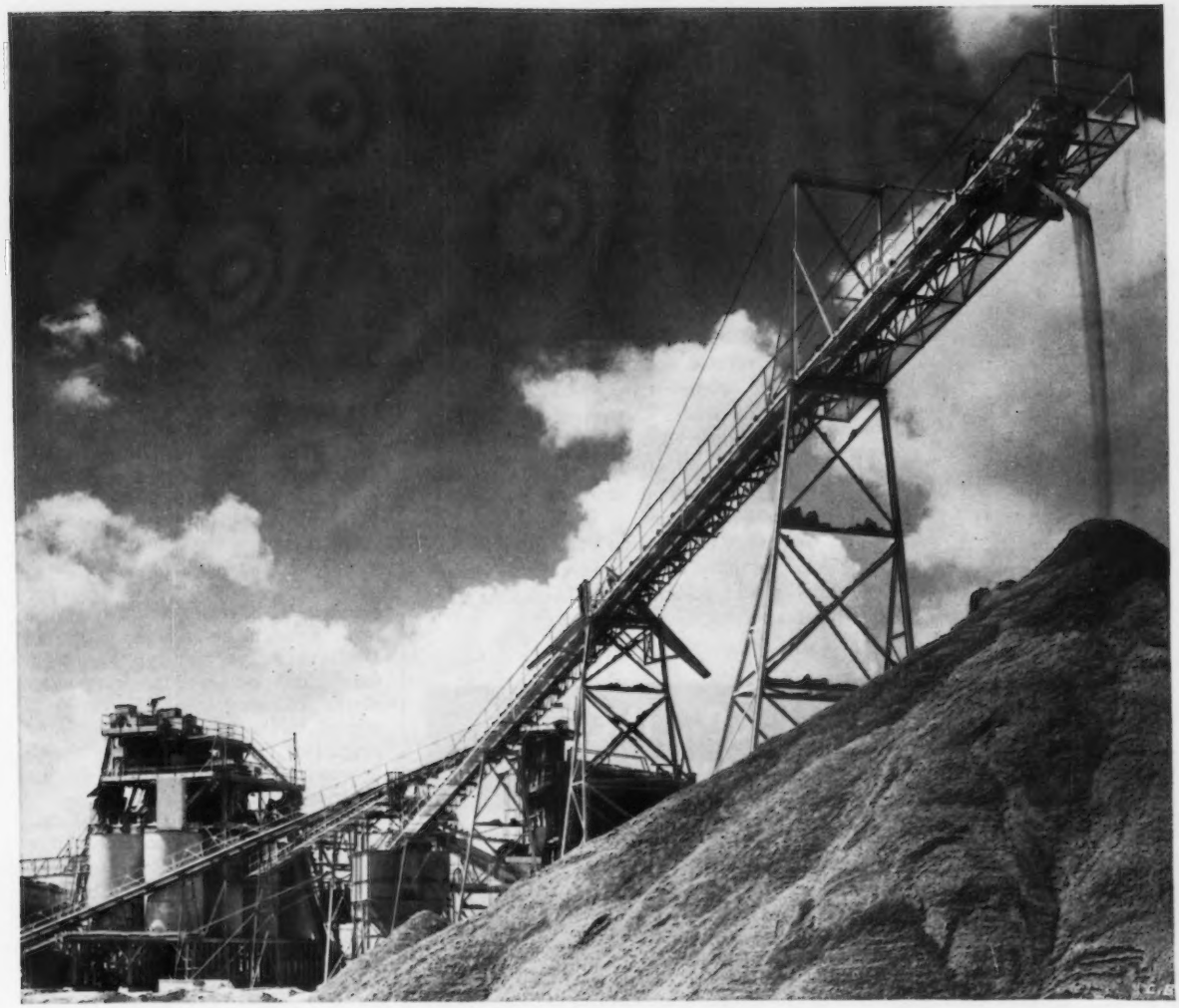
Galena flotation concentrates . . .	31.0%
Zinc plant leach residues	9.4%
Reclaimed dump slag	14.0%
Fumes and dusts	6.0%
Limerock	5.9%
Silica fluxes	3.7%
Return sinter	30.0%
Total	100.0%

The following advantages of updraft furnaces over downdraft types were cited by the authors, speaking in reference to lead-zinc treatment:

(Continued on p 154)



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Symposium *(Continued)*

1) Pellets tend to pack less when the updraft levitates the bed, so pellet size is less critical;

2) Upward gas flow seems to prevent liquid phases from running together into a dense mass. The liquids form droplets, but the droplets are held suspended in the charge by the rising gas stream and "freeze" before they can further consolidate.

3) The updraft system is generally more versatile and less sensitive to the method of charge preparation than in downdraft. The final endorsement of the system, by Mr. Ingvoldstad, came at the end of his presentation, and after technicians from Broken Hill and Trail had offered suggestions and notes on practices in their plants. "Without this method," said the Bunker Hill man, "we couldn't compete in today's lead market."

Kenneth E. Merklin, in delivering a paper which he co-authored with Fred D. DeVaney, of Pickands Mather & Co., Duluth, discussed the coarse specularite fine magnetite which PM is mining in the Labrador Trough and noted that the problem of the choice between pellets and sized, self-fluxing sinter is being studied.

In laboratory tests, PM found that some 30% of the recoverable iron from Wabush was in the form of magnetite, with the balance being mostly hematite. While the hematite could be liberated with a grind at about minus 28 mesh, the magnetite concentration required further grinding to minus 325. However, it was the mixture of about 31% minus 325 material with the specular hematite that seems to provide the best basis for a pelletizing program. In the questioning, Mr. Merklin mentioned that PM could grind to minus 28 for 2 kwh. but it required an additional 15 to 17 kwh to get down to minus 325.

Wayne E. Apuli and K. M. Hanley, of Reserve Mining Co., Silver Bay, Minn., presented a paper on the horizontal grate pelletizer performance at the E. W. Davis works of Reserve.

The balling unit at the plant was described as consisting of a 450-ton concentrate storage bin with a variable feeder, bentonite and coal bins with proportioning feeders, a 9x30 ft balling drum, a green pellet screen, an 8x12 ft coal coating drum and conveyors. Three balling drums serve each of six grate machines.

Mr. Apuli, in offering the paper, cited the two main factors which positively change the balling characteristics of concentrate: moisture content and mean particle size. The former is considered critical and, while it

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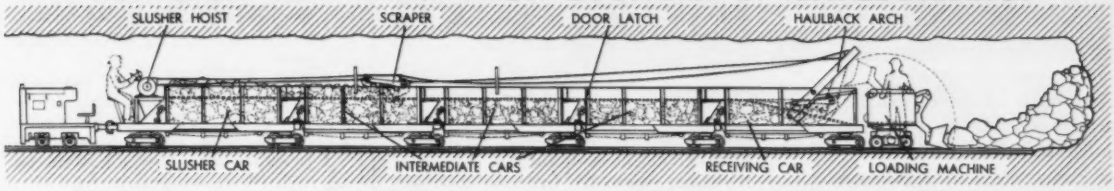

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The slusher operator keeps the receiving car cleaned out by progressively filling each car to the slusher support bar level and then retreating as the cars become heaped. Two men handle the entire operation. No switching is required — no cars to couple or uncouple—offering tremendous savings in time as well as eliminating one of the most frequent causes of mine accidents. After tunnel driving is completed, the Trainloader may be used for production haulage. Its overlapping design allows continuous spillage-free loading from chutes or conveyors. Consider the savings in labor, time, and expense that a Trainloader will offer your operation and then write, phone or wire the Coeur d'Alenes Company, Wallace, Idaho, USA.

U. S. Patent No. 2,873,866. Canadian Patent No. 709,464. Foreign patents pending.

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Symposium *(Continued)*

must vary with type of ore and feed, PM has found 10% moisture by weight to be most satisfactory as an average.

In his treatment of surging, an area which subsequently developed some discussion from the floor, Mr. Apuli listed the major causes:

1) weight of the new feed;
2) non-uniform rotation of the drum; and
3) texture of the drum lining.

To avoid the first cause, the authors said, "We weigh the incoming feed and instrument-control the table feeder speed to compensate for changes in the feed rate." In the second case, Mr. Apuli noted that an unbalanced drum can alter rotation and start a surge, and insufficient power to maintain constant speed under a load can contribute.

The third factor, drum lining, is maintained by trimming the lining with a special cutter bar. Another cause of surging, the authors found, is the degree of moisture in the feed.

The proceedings will be published in a hard-bound volume containing the papers, prepared discussions, floor discussions and authors' closures. It is believed the book will run between 800 and 1,000 pages. Distribution is scheduled for the fall, with a volume going to each registrant. The registration fee, $25 for AIME members and $27.50 for non-members, includes a copy. Additional copies will be $20 each for members and $25 each for non-members.

A tour of the Grace Mine, operated by Bethlehem-Cornwall Corp. at Morgantown, Pa. was made by about 100 of the registrants. The mine concentrator and pelletizing plant (as well as the offices and auxiliary buildings) are constructed in what has become a Bethlehem tradition of good taste and awareness of the mine's role as a member of its community. Like the Marmora mine in Ontario, it is an example of integrating structures and roadways into the landscape for the benefit of both mine and community.

Grace is expected to reach full production of 12,000 tpd of ore this year (steel demand permitting). Production started in November 1958, but the pelletizing plant, which makes a 63- to 65% Fe pellet, completed its shakedown only two months ago. Previously, concentrates had been shipped to other Bethlehem facilities.

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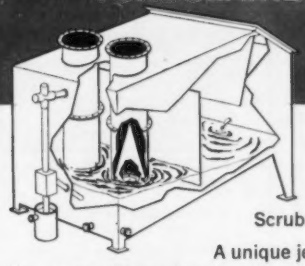

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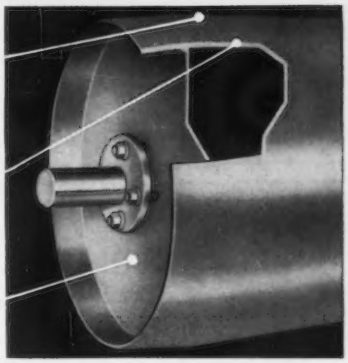

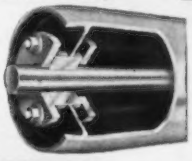

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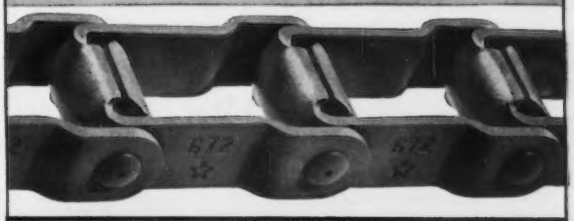

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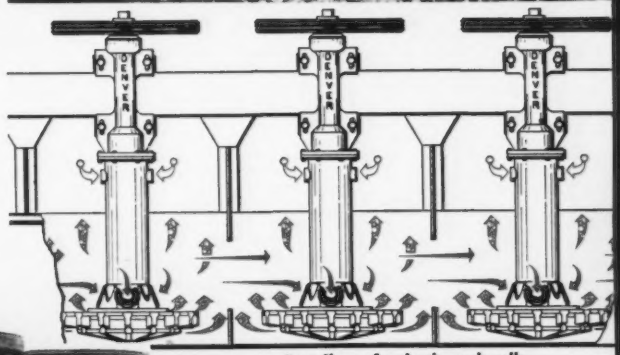

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